The Engineer.

Established 1856. Registered as a Newspaper.

OFFICE FOR ADVERTISEMENTS & PUBLICATION, 28, ESSEX ST., STRAND, LONDON, W.C. 2.

VOL. CLI.—No. 3929] LONDON: FRIDAY EVENING, MAY 1, 1931 [PRICE { WITH SUPPLEMENT } ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

For Sale.—Four Dis-

MANTLED HYDRAULIC PRESSES for general purposes, with Intensifier. Designed for a pressure of 700 lb. per square inch, or an intensified pressure of 3360 lb. per square inch, complete with interconnecting pipes and operating valves.

Size of press tables	2ft. by 2ft.
Clear height for goods	4ft. 6in.
Diam. of press ram	6in.
Stroke of ditto	2ft.

Constructed by the Hydraulic Eng. Co., Ltd., Chester, about 1893.

All in good serviceable condition.

May be seen at the INDIA STORE DEPARTMENT, Belvedere-road, Lambeth, London, S.E. 1, between 10 a.m. and 5 p.m. (Saturday, 1 p.m.). 6920

Royal Corps of Naval

CONSTRUCTORS.

A COMPETITIVE EXAMINATION for a POST as PROBATIONARY ASSISTANT CONSTRUCTOR will be held at the Royal Naval College, Greenwich, during the first fortnight in July next.

Candidates must not be more than 24 years of age on 1st October next, and must then have been engaged in practical shipbuilding work for at least 18 months. Graduates from the Universities are preferred.

The salaries and other conditions of service are given in full in the regulations of the Royal Corps of Naval Constructors. The salaries during the two or three years' Greenwich course, including cost-of-living bonus reckoned at its present rate of 55, are approximately as follows :—

Probationary Assistant Constructors on joining R.N. College, £177 in addition to mess allowance.

Probationary Assistant Constructors during second half of course, £302 in addition to mess allowance.

Candidates successful at the end of the R.N. College course will be admitted into the Royal Corps of Naval Constructors as permanent Civil Servants, with corresponding superannuation and other privileges, the salaries, including bonus as above, of the lower grades being approximately as follows :—

2nd Class Assistant Constructor (first 3 years), £301-£337.

1st Class Assistant Constructor (after 3 years), £408, rising to £680.

The salaries, &c., for the higher grades are stated in the regulations, which may be obtained from the SECRETARY OF THE ADMIRALTY (C.E. Branch), Whitehall, S.W. 1, to whom intending candidates must submit their names and full particulars of their educational and technical training and practical experience not later than the 23rd proximo.

PRIVATE STUDENTS OF NAVAL ARCHITECTURE.

A QUALIFYING EXAMINATION will be held in conjunction with the above, for the admission to the Royal Naval College, Greenwich, of PRIVATE STUDENTS of NAVAL ARCHITECTURE who desire to receive instruction in the course laid down for PROBATIONARY ASSISTANT CONSTRUCTOR. Applications for admission as Private Students should reach the SECRETARY OF THE ADMIRALTY (C.E. Branch) not later than the 23rd proximo.

Private Students are required to pay a fee of £50 per session.

Applications for the regulations should be accompanied by an addressed foolscap envelope. 6829

University of London.

A COURSE of FOUR LECTURES on "STEAM RESEARCH IN EUROPE AND IN AMERICA," will be given (in English) by Professor Dr. Ing. MAX JAKOB (Professor of Engineering and Technical Physics in the Physikalische-Technische Reichsanstalt, Berlin), at THE INSTITUTION OF CIVIL ENGINEERS, Great George-street, Westminster, S.W. 1, on THURSDAYS and FRIDAYS, MAY 7th, 8th, 14th and 15th, 1931, at 5.30 p.m. At the first Lecture the chair will be taken by Professor E. G. Coker, D.Sc., F.R.S., M. Inst. C.E. (Member of Council of the Institution of Mechanical Engineers). ADMISSION FREE, WITHOUT TICKET. Lantern illustrations.

S. J. WORSLEY,
Academic Registrar.
6819

County Borough of North-

AMPTON.

HIGHWAYS AND FARM AND SEWAGE DISPOSAL COMMITTEES.

TENDERS are INVITED by the Corporation from competent Public Works Contractors for the CONSTRUCTION of the several WORKS included in the following Contracts :—

CONTRACT NO. 1 (SECTION A).

Construction of Automatic Pumping Station at Bedford-road, Northampton, with Storm Water Sump for the Installation of No. 2, 10in., and No. 2, 12in. Centrifugal Pumps.

(SECTION B).

Construction of 3¼ Miles of 5ft. diameter Main Outfall Conduit (Concrete Tube).

700 Yards of 3ft. 9in. diameter Storm Water Conduit with Storm Water Weirs, &c.

CONTRACT NO. 2.

Construction of Sewage Disposal Works, consisting of Detritus Tanks, Screening Chamber, Dortmund Tanks, Humus Tanks, and Main Effluent Carriers, &c., at Great Billing, near Northampton.

CONTRACT NO. 3.

ST. JAMES' DISTRICT MAIN DRAINAGE.

Construction of approximately 950 Lineal Yards of Cast Iron Pipe Sewers, varying in size from 30in. to 42in. diameter; also 2880 Lineal Yards of Concrete Tube Sewers, 18in. to 42in. diameter.

Construction of Pumping Station, including Machinery, &c., Rising Mains, and Sewage Tank.

CONTRACT NO. 4.

FAR COTTON DISTRICT MAIN DRAINAGE.

Construction of approximately 2046 Lineal Yards of Cast Iron Pipe Sewers, 21in. to 33in. diameter.

Plans may be inspected at the office of the Borough Engineer, Mr. Alfred Fidler, M. Inst. C.E., Borough Engineer, Guildhall, Northampton, from whom forms of Tender, specification and bills of quantities may be obtained, on and after May 4th, 1931, on deposit of Five Pounds for each of the four Contracts (crossed cheques made payable to "Northampton Corporation"), and which deposits will be returned upon receipt of a bona fide Tender in each case, and of all the documents forwarded to the Contractor for the purpose of preparing his Tenders.

With the exception of Contract No. 1 (Main Outfall), &c., the Contractors carrying out the work will be required to comply with the regulations of the Unemployment Grants Committee with regard to the employment of labour during the performance of the Contract.

Sealed Tenders, upon the forms provided, must be received by the undersigned not later than 10 a.m. on Wednesday, the 27th May, 1931, endorsed "Main Sewerage and Sewage Disposal Works," with the number of Contract to which the Tender applies.

The Corporation do not bind themselves to accept the lowest or any Tender, nor to pay any expenses incurred by persons tendering.

W. R. KEW,
Town Clerk.

Guildhall, Northampton,
April 27th, 1931. 6828

The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE.
ARRANGED FOR CARD INDEXING.

250-Ton Hammer-Head Crane (P. 492)
(With a Two-page Supplement).
THE ENGINEER, 1 - 5 - 31.

Main Line Railway Electrification. (P. 489)
THE ENGINEER, 1 - 5 - 31.

Effect of Use on Motor Oils. (P. 476)
(S. L. SMITH AND E. GLAISTER.) THE ENGINEER, 1 - 5 - 31.

Efficiency in the Tool Department. P. 479,
(G. W. TRIPP.) THE ENGINEER, 1 - 5 - 31.

Post-War Land Turbine Development. (P. 481)
(C. D. GIBB.) THE ENGINEER, 1 - 5 - 31.

A New Single-Deck Motor Coach. (P. 494)
THE ENGINEER, 1 - 5 - 31.

7600 B.H.P. Double-Acting Two-Stroke Oil Engine. (P. 484)
THE ENGINEER, 1 - 5 - 31.

Hungarian Railway Electrification. (P. 491)
THE ENGINEER, 1 - 5 - 31.

INDEX TO ADVERTISEMENTS, PAGE 67.

PUBLIC NOTICES

Abingdon Corporation Water-

WORKS.

SANDFORD INTAKE WORKS.

CONTRACT NO. 1.

The Corporation of Abingdon are prepared to receive TENDERS for the CONSTRUCTION of INTAKE WORKS and other works incidental thereto in accordance with the drawings and specification prepared by the Consulting Engineers, Mr. T. W. Ellis, M.I. Mech. E., M.I.E.E., in collaboration with Mr. A. P. I. Cotterell, M. Inst. C.E.

Drawings and specification may be seen at the office of the Borough Engineer and Surveyor, Mr. W. H. Lewis, M.I.M. and Cy. E., The Abbey House, Abingdon, Berks., or at the offices of the Consulting Engineers, 70 or 54, Victoria-street, S.W. 1, respectively, during the usual office hours on or after the 5th May, 1931.

Copies of bills of quantities and form of Tender may be obtained from the Consulting Engineers by intending contractors on and after the 5th May, 1931, on payment of the sum of £2 2s., which will be returned on receipt of a bona fide Tender, based on the specification, and which has not been withdrawn prior to the definite acceptance of a Tender by the Corporation.

The copy of the specification and all other documents supplied are to be returned, filled up, signed and intact, to the undersigned, and to be received by him before 10 a.m. on the 16th May, 1931, enclosed in a sealed packet marked on the outside "Sandford Intake Works."

The lowest or any Tender will not necessarily be accepted, nor will any expense in connection with tendering be defrayed.

W. CARLYLE CROASDELL,
Town Clerk.

The Abbey House, Abingdon.
Date: 24th April, 1931. 6823

Great Western Railway.

The Directors of this Company are prepared to receive TENDERS for the EXTENSION of a MOTOR GARAGE at Westbourne Park, London, W.

Plans may be seen and forms of Tender, specification, and bills of quantities obtained at the office of the Engineer at Paddington Station, between the hours of 10 a.m. and 4 p.m., on payment of Two Guineas, which will be returned to bona fide tenderers.

Tenders, addressed to the undersigned and marked outside "Tender for Garage Extension at Westbourne Park," will be received not later than 10 a.m. on Monday, the 11th proximo.

The Directors do not bind themselves to accept the lowest or any Tender.

F. R. E. DAVIS, Secy.

Paddington Station, London, W. 2,
22nd April, 1931. 6825

PUBLIC NOTICES

Administrative County of

LONDON.

The London County Council invites TENDERS for the SUPPLY, DELIVERY and ERECTION of ONE IRONING MACHINE to the Manor Certified Institution, Epsom, Surrey.

The specification, form of Tender, &c., may be obtained on application to the Chief Engineer, The Old County Hall, Spring-gardens, S.W. 1, on and after Wednesday, 29th April, 1931, upon payment of £1 by cheque, draft, or money order to the order of the London County Council.

This amount will be returnable only if the tenderer shall have sent in a bona fide Tender and shall not have withdrawn the same. Full particulars of the work may be obtained on personal application, and the contract documents may be inspected before payment of the fee.

Remittances by post should be addressed to the Chief Engineer, The Old County Hall, Spring-gardens, S.W. 1. Personal inquiries at Room 2, No. 3, Warwick House-street, Cockspur-street, S.W. 1.

The contractor will be bound to observe the provision of a fair wages clause, the terms of which are set out fully in the instructions for Tender and form of contract and in "The London County Council Gazette."

No Tender received by the Clerk of the Council at the County Hall, Westminster Bridge, S.E. 1, after 4 p.m. on Monday, 11th May, 1931, will be considered.

The Council does not bind itself to accept the lowest or any Tender.

MONTAGU H. COX,
Clerk of the London County Council.
6833

Peterhead Harbours.

SLIPWAY APPLIANCES.

The Trustees of the Harbours of Peterhead invite TENDERS for the SUPPLY, DELIVERY, ERECTION and TESTING of STEEL CRADLES, TRAVERSER and MACHINERY required for a SLIPWAY with Traversing Arrangements, and a LIFTING BRIDGE at Peterhead Harbour.

Drawings and contract documents may be inspected at the office of Messrs. Henderson and Nicol, Chartered Civil Engineers, 21, Bridge-street, Aberdeen, from whom copies of specification, conditions of contract, schedules, forms of Tenders and drawings may be obtained on payment of a charge of £3 3s., which will not be returnable.

Sealed Tenders, endorsed "Tender for Slipway Appliances," must be lodged with the undersigned not later than the 23rd of May, 1931.

The Trustees do not bind themselves to accept the lowest or any Tender.

ALEX. DAVIDSON,
Clerk to the Trustees of the Harbours of Peterhead.
6826

PUBLIC NOTICES

The Manchester Steam Users'

ASSOCIATION.

For the Prevention of Steam Boiler Explosions and for the Attainment of Economy in the Application of Steam, 20, QUAY-STREET, DEANSGATE, MANCHESTER.

Founded 1854 by Sir WILLIAM FAIRBAIRN.

Certificates of Safety issued under the Factory and Workshops Act, 1901. Compensation for Damages and Liabilities paid in case of Explosions. Engines and Boilers Inspected during construction. 6605

Metropolitan Water Board.

TENDERS FOR THE SUPPLY OF STORES, &c.

The Metropolitan Water Board invite TENDERS for the SUPPLY of the undermentioned STORES and SERVICES, &c., for periods of 6 and 12 months, commencing 1st June, 1931 :—

Tender No.	
1	Bricks, Fire-bricks, Cement, &c.
8	Iron and Steel.
9	Bolts and Nuts, Screws, Files, Shovels, Steam Tubes, &c.
12	Fuel Oil, Oils (Lubricating), Kerosene, Motor Spirit, Greases, Tallow, &c.
19	Iron, Brass, Gun-metal, and other Castings.
20	G.M. Stop Cocks and Ferrules, Outlets and Caps for Fire Hydrants.
22	Timber.
23	Maintenance of Weighing Machines.

Tenders must be submitted on the official forms, which may be obtained from the Chief Engineer by personal application at the offices of the Board (Room 155) or upon forwarding a stamped addressed sack envelope.

Applicants should refer to the number of the Tender for which forms are required.

Tenders, enclosed in sealed envelopes, addressed to "The Clerk of the Board" and endorsed in the manner indicated in the form of Tender, must be delivered at the offices of the Board (Room 122) not later than 11 a.m. on Monday, 11th May, 1931.

The Board do not bind themselves to accept the lowest or any Tender.

G. F. STRINGER,
Clerk of the Board.

Offices of the Board,
173, Rosebery-avenue, E.C. 1.
18th April, 1931. 6875

Wanted by Large Municipality

in Yorkshire, the following EXCAVATING and 2ft. GAUGE LIGHT RAILWAY PLANT, in very good condition :—

One Power Excavating Shovel, ¾ or 1 cu. yd. Bucket, preferably Internal Combustion Engine-driven, and with Caterpillar Travelling Gear.

One Head Gear with Foot and Hand Screw-operated Brakes for Self-acting Incline, capable of dealing with loads of 30 to 45 tons down and 10 to 20 up an incline 700ft. long—maximum 1 in 8½.

One Mile 2ft. Track, 20 to 35 lb. Rails, with Turnouts and Fittings.

Four 20 to 30 H.P. Tractors, or Light Locos.

Sixty 27 to 36 cu. ft. Heavy Type Tip Wagons, for use with the above.

Particulars and offers to be submitted to 6922, The Engineer Office. 6922

County Borough of Newport,

MON.

TALYBONT RESERVOIR CONSTRUCTION.

ASSISTANT WATERWORKS ENGINEER (TEMPORARY) REQUIRED IMMEDIATELY. Must have had considerable experience in the design of Earth Dams and Ancillary Works and the Preparation of Working Drawings. Probable duration of work five years. Commencing salary £400 per annum.

Applications, endorsed "Assistant Waterworks Engineer," stating age, details of experience in chronological order, and accompanied by copies of not more than three recent testimonials, to be sent to the undersigned not later than 12th May, 1931.

W. E. LLOYD, M. Inst. C.E.,
Borough and Water Engineer.

Town Hall, Newport, Mon.,
28th April, 1931. 6834

The Commissioners of Sewers

FOR THE LEVEL OF NEW ROMNEY, KENT.

The Commissioners will shortly be REQUIRING the SERVICES of a RESIDENT ENGINEER or CLERK of the WORKS to supervise the Construction, by contract, of a Reinforced Concrete Sea Wall, Groynes, &c.

Applications, stating salary required and accompanied by copies of two recent testimonials, to be forwarded to the undersigned not later than Wednesday, the 6th May.

M. DU-PLAT-TAYLOR, M. Inst. C.E.,
Consulting Engineer to the Commissioners.
36, Victoria-street, Westminster, S.W. 1. 6822

PUBLIC NOTICES (continued) Page 2.
SITUATIONS OPEN, Page 2.
SITUATIONS WANTED, Page 2.
FOR HIRE, Page 68.
AUCTIONS, Page 68.
MACHINERY, &c., WANTED, Page 68.
PATENTS, Page 2.
AGENCIES, Page 2.
MISCELLANEOUS, Page 2.
EDUCATIONAL, Page 2.
BUSINESSES and PREMISES (For Sale, etc.). Page 68.
FOR SALE, Pages 4 and 68
WORK WANTED, Page 68.

For Advertisement Rates see Leader Page.

PUBLIC NOTICE

Government of Bombay.

NOTICE.

To IRRIGATION DEPARTMENTS, PORT AUTHORITIES, RAILWAYS, MUNICIPALITIES, ELECTRIC SUPPLY COMPANIES, PUBLIC WORKS CONTRACTORS AND OTHER ADMINISTRATIONS CARRYING OUT LARGE ENGINEERING WORKS.

Notice is hereby given that, owing to the approaching completion of the Lloyd Barrage at Sukkur, large quantities of Plant and Machinery as briefly detailed in the list below will shortly become available for sale. The bulk of the plant will not be available until after June, 1931, but some plant is now available and other plant will become available shortly.

All Administrations who have works in progress or who are contemplating works in the near future are invited to consider the subjoined list and to apply to the undersigned for full particulars and prices of any plant which might be of use to them. Enquiries are NOT invited from machinery dealers at the present stage. Most of the plant was purchased new for these works and is in excellent condition. Every item of plant sold will be first overhauled and put in thorough working order before sale and will be open for inspection (and test, wherever possible) by appointment at Sukkur.

Service will also be given after sale and purchasers' men will be trained by arrangements, as long as the Barrage Construction Works and Shops are in existence.

A. A. MUSTO,
C.I.E., M.I.C.E., I.S.E.,
Superintending Engineer, Lloyd Barrage Circle.
Postal Address: Sukkur, Sind, India. Cables: "SUKBAR, SUKKUR."

LIST OF PLANT & MACHINERY.

RAILWAYS.
About 40 miles of 5ft. 6in. gauge Railway complete and 9 Steam Locomotives and about 700 Wagons of all types, including 20-Ton Either-side Tipping Wagons. About 25 miles 2ft. gauge Railway complete and 15 Kerosine and 2 Steam Locos. and about 1100 Either-side Steel Tip Wagons of 27 cubic feet capacity.

FLEET.
Two Shallow-draught Suction Dredgers, by Lobnitz, 20in. discharge, to dredge to 30ft. each, complete with 1000ft. Floating Pipe Line and Terminal Pontoon with 150ft. overhang at 40ft. above water line.
Also Shallow-draught Paddle and Twin-screw Tugs, Motor Launches, Steel Barges, Pontoons, &c.
NOTE.—All motors on electrically driven plant are for A.C., 400 volts, 3-phase, 50 periods.

CRANES.
25-Ton and 10-Ton Electric Floating Derrick Cranes, 10 Ton and 14-Ton Electric Derrick Cranes, 20-Ton and 2-Ton Steam Derrick Cranes. Also 5-Ton Steam Loco. Cranes and 10-Ton Electric Loco. Cranes, 5ft. 6in. gauge. Also 15-Ton, 12-Ton and 5-Ton Electric Goliath Cranes, 15-Ton Electric Shop Gantry Crane, and 15-Ton Hand-operated All-round Derrick Cranes.

PUMPS.
Sets of 8in., 4in., 3in., and 2in. Direct-coupled Electric Centrifugal Pumps for 40ft. head.

PILE DRIVERS.
Floating and Land Sets with McKiernan-Terry Double-acting Piling Hammers, Spencer-Hopwood Boilers, Zenith Winches and Steel Frames and Leads for driving 45ft. Piling.

STONE CRUSHERS.
"Acme" Jaw Crushers, 24in. by 15in., with Elevators, Hoppers and Screens and Portable, Crusher, 12in. by 6in.

CONCRETE MIXERS.
Complete Plants for Moulding 10-Ton Blocks with Travelling Mixer Bridge carrying 2-Yard Ransome Mixers complete with Bunkers, Elevators and Batch Measuring Hoppers for materials, all electric driven. Also Steel Moulds for 10-Ton and 1½-Ton Blocks. Also Electric-driven Portable Mixers of sizes.

AIR COMPRESSORS.
Direct-coupled Electric-driven Sentinel Two-stage Compressors of 300 cubic feet capacity. Belt Drive Ditto of 550, 300, 188, and 140 cubic feet capacity respectively. Pneumatic Tools of all kinds.

DIVING GEAR AND DRESSES, &c.

ELECTRIC POWER PLANT.
Following Diesel Engines direct coupled to Alternators generating A.C., 6600 volts, 3-phase, 50 periods:—
2 Swiss Loco. 4-Cylinder Single-acting Diesels, 750 B.H.P., with Fly-wheel Alternator, 500 kW. by Oerlikon.
Metro-Vickers Cubicle Type Switchboard.
Johnson and Phillips Transformers, 6600 to 400 volts, of sizes.
H.T. and L.T. Overhead Transmission Poles, Cables, &c.

MORTAR MILLS.
Both Over-driven and Under-driven Type Mortar Mills, 6ft. dia. pans, with belt drive from countershaft.

WORKSHOP MACHINERY.
Lathes, Shapers, Planers, Milling Machines, Drilling Machines, Belt Air Hammers, Belt Hammers, Punching and Shearing Machines, Forges, Wood working Machinery, Plate Rolls, Iron and Brass foundry Equipment, Saw Sharpening Machines, &c.

QUARRY PLANT.
Compressed Air Drills of all sizes, Forging Machines, Oil Furnaces, Air Compressors, Oil Engines, Wire Saws, Channellers, &c.

STONE DRESSING PLANT.
Diamond Saws, Planers, Frame Saws, Rip Saws, Countershafts, &c.

ENGINES.
Oil Engines of various sizes.

BUILDINGS.
Steel-framed Stone Dressing Shop, 360ft. by 115ft., with 15-Ton Gantry Runway and numerous Smaller Steel Roof Trusses, &c.

STEEL SHEET PILING.
About 11,000 Tons "Universal" 15in. by 5in. by 43 lb. per square foot Interlocking S.S. Piling in 40ft., 45ft., and 50ft. lengths.

MISCELLANEOUS PLANT.
Such as Steel Riveted and Sectional Tanks of all sizes, with and without Staging, Winches, Jacks, Pullers, Wire Ropes, Motor Lorries, and many other items.

A. A. MUSTO,
S.E.L.B.C.
MS.13/10. P.B. 40/30. 6445

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

WANTED, on Up-to-date Brickworks in the Midlands, a WORKING ENGINEER who thoroughly understands Diesel Engine and Electric Motors.—Address, 6919, The Engineer Office. 6919 A

AN OPENING OCCURS for a Young CIVIL ENGINEER with two or three years' experience on outside work.
Address, stating age, experience, and salary required, P1018, The Engineer Office. P1018 A

ASSISTANT ENGINEERS REQUIRED, with Experience of Compressed Air Tunnelling. Also DRAUGHTSMAN, with knowledge of Reinforced Concrete and General Civil Engineering Design. Give full particulars of experience, salary required, and when disengaged.—Address, P1038, The Engineer Office. P1038 A

ENGINEER REQUIRED for a Large Textile Works in Lancashire, to Take Charge of Repair and Maintenance Work, Steam Raising and Electrical Driving. Previous textile experience not essential if first-class engineering qualifications. Applicant must be a good disciplinarian and able to delegate his duties. Good prospects. Replies, which will be regarded as confidential, should state age, experience, and salary required.—Write, Box 124, c/o Judd's, 47, Gresham-street, E.C. 2. 6876 A

ENGINEER SALESMAN for London, Experienced in Conveyor Work and capable of selling Conveyor, Elevator and Transmission Belting; also Mechanical Rubber. Write full particulars stating age and salary required.—Box "O 29," W. H. Smith and Son, Ltd., Strand House, W.C. 2. P1036 A

LARGE IRONFOUNDRY, Making Domestic Iron-work for disposal mainly to builders' merchants, REQUIRES capable SALES MANAGER. Must have initiative.—Address, giving full particulars, 6916, The Engineer Office. 6916 A

PRODUCTION ENGINEER WANTED by well-known Company.
Essentials: Age 28-35; sound general and technical education (University Degree or equivalent in Engineering); 4-5 years' practical workshop experience; really first-class knowledge of Works Management and Modern Production Methods acquired while holding executive position.
Commencing salary commensurate with high standard demanded.
Unique prospects offered to the right man.
Address, stating age and giving detailed chronological statement of education and career, with salaries earned, 6915, The Engineer Office. 6915 A

REQUIRED for Large Structural Works Abroad, ASSISTANT STRUCTURAL MANAGER, experienced in Heavy Bridge Work, spans 300ft. and over; must have held similar position and also hold a B.Sc. or equivalent degree. Age between 30 and 35. Agreement 5 years. Applicants must give fullest details education, training, work done, present position and salary. State age and whether married or single.—Write, Z.K. 452, c/o Deacon's Advertising Offices, Fenchurch-avenue, London. 6831 A

THE LEADING COMPANY Manufacturing Machinery and Supplies for one of the Staple Industries REQUIRES, to assist its Chief Engineer in directing the work of its Inventing, Designing and Experimental Manufacturing and Testing Staffs, an ENGINEER (preferably about 30 years of age), with first-class University qualifications in Engineering Subjects or Science, and a successful record of experience of the Utilisation of Machinery of varied types in the mass production of goods of different classes. Some knowledge of Industrial Chemistry desirable.
Commencing salary fully commensurate with high standard of qualifications and experience expected.
Address, 6924, The Engineer Office. 6924 A

ASSISTANT CHIEF DRAUGHTSMAN.
For Firm of Engineers specialising in Oil Refinery Work. Experienced in Steel Plate Work, Constructional Work and Pipe arrangements. Must be quick, accurate and able to take full responsibility for Pressure and Loading Calculations.
Knowledge of metric measurements and quantities and technical French an advantage.
State age, experience and salary.
Address, P1040, The Engineer Office. P1040 A

DRAUGHTSMAN.
For Oil Refinery Work. Experienced in Cast Iron, Mild Steel and Constructional Details.
Must be quick, neat and accurate. Knowledge of metric measurements and quantities and technical French an advantage. State age, experience and salary.
Address, P1041, The Engineer Office. P1041 A

DRAUGHTSMAN (Temporary) REQUIRED AT ONCE; experience in Sewerage, Water Supply, and Quantities, accurate leveller.—State salary, send references, and small example of draughtsmanship to PARKER, PEARSON and ROSS HOOPER, MM. Inst. C.E., Chippenham, Wilts. 6918 A

SITUATIONS WANTED

ACTIVE ENGINEERING EXECUTIVE (32), Public school and university education, thorough engineering and business training at home and abroad, REQUIRES POST in London.—Address, P1027, The Engineer Office. P1027 B

AS COST ACCOUNTANT, or any Other Responsible Post which requires practical knowledge of works' organisation and control. Age 29, single; good experience and qualifications. Home or abroad.—Address, P1035, The Engineer Office. P1035 B

ENGINEER (29), First-class B.O.T. and National Certificate, SEEKS SITUATION, home or abroad.—Address, P1039, The Engineer Office. P1039 B

EXPERIENCED ENGINEER, A.M.I.C.E., REQUIRES POSITION. Small capital available, excellent references; just returned from abroad.—L. G. M., c/o Hodder, Solicitor, 4, Finsbury-square, E.C. 2. P6917 B

EXPERIENCED ELECTRICAL MECHANICAL ENGINEER, economist, good organiser, managerial control of labour, factory maintenance and erection of plant, accustomed to handling specifications, drawings, estimates, schemes and correspondence, SEEKS POSITION of responsibility.—Address, P1022, The Engineer Office. P1022 B

EXPERIENCED ORGANISER REQUIRES POST, capable of taking entire management, production, piecework or bonus rate-fixing, control of all labour, expert costs and work accountancy by clerical or mechanical methods, stores control, sales, etc. Advertiser is middle-aged and can show excellent past records, and is accustomed to the electrical, agricultural, motor and general engineering. Moderate salary only.—Address, P1037, The Engineer Office. P1037 B

SITUATIONS WANTED (continued)

GENTLEMAN (36), Chief Buyer and Stores Supt. to large engineering works, wide knowledge commercial practice, cost accounting, factory organisation, REQUIRES EXECUTIVE APPOINTMENT or would undertake representation. Highest credentials.—Address, P1026, The Engineer Office. P1026 B

HEATING ENGINEER, with Expert Knowledge in design and erection, technical, practical, commercial and costing, experience. All systems steam and water. SEEKS SITUATION, Office or Supervision. Age 58 years. First-class references.—Address, P1042, The Engineer Office. P1042 B

HIGH-SPEED C.I. ENGINES.—DRAUGHTSMAN-DESIGNER, 12 years' oil engine experience, 3 years' design successful high-speed C.I. engine, SEEKS SITUATION through change in policy of firm.—Address, P1032, The Engineer Office. P1032 B

PLANT REORGANISATION. — Civil - Mechanical ENGINEER, M.I. Struct. E., M.I. Prod. E., with unique up-to-date experience of plant lay-out, design and equipment for mass production, in U.S.A., England and Continent, SEEKS CHANGE, permanent or advisory capacity; would also like consider partnership.—Address, P979, The Engineer Office. P979 B

YOUNG ENGINEER (24) DESIRES POST. Design and detailing of structural steel work and R.C., erection of bridges, &c., setting out, level and theodolite.
Address, P1017, The Engineer Office. P1017 B

YOUTH SEEKS POST as Junior Draughtsman in Engineering firm; age 20; three years' mechanical experience; technical education.—J. C. MITCHELL, Tanners-lane, Haslemere, Surrey. P1034 B

DRAUGHTSMAN (29), London, 3 Yrs. Tech. College, 5 yrs. shops, 8 yrs. D.O., centl. and recips. pumps, gears and general.—Address, P1033, The Engineer Office. P1033 B

JUNIOR DRAUGHTSMAN (18), with Knowledge of levelling and surveying, REQUIRES POSITION. Will accept situation away. Moderate salary. Excellent refs.—E. S., 1, Osborne-road, Thornton Heath. P1029 B

EDUCATIONAL

Correspondence Courses
OF
PREPARATION
FOR THE
Examinations
OF THE
INST. OF CIVIL ENGINEERS.
INST. OF MECHANICAL ENGRS.
INST. OF STRUCTURAL ENGRS.
UNIVERSITY OF LONDON, &c.
ARE PERSONALLY CONDUCTED BY
Mr. Trevor W. Phillips,
B.Sc., Honours, Engineering, London University. Assoc. M. Inst. C.E., A.M.I. Struc. E., M.R.S.I., F.R.S.A., Chartered Civil Engineer, &c.
For full particulars and advice apply to:—
30, DALE STREET, LIVERPOOL.
LONDON OFFICE:—65, CHANCERY LANE, W.C. 2.

Oxford Correspondence College,
BEAUMONT HOUSE, OXFORD.
THOROUGH POSTAL PREPARATION FOR:—
B.Sc. (ENGINEERING), Pass and Honours.
A.M.I.C.E.,
A.M.I.M.E.,
and also Electrical, Structural, Aeronautical, Automobile and Marine Engineering Examinations.
Low Fees—payable monthly. 50 Tutors, Individual attention. Textbooks loaned.
Prospectus from the Secretary.

T.I.G.B.
CORRESPONDENCE COURSES
FOR THE
PROFESSIONAL EXAMINATIONS
(A.M. Inst. C.E., A.M.I. Mech. E., A.M.I.E.E., etc.

Convincing proof that The T.I.G.B. training is markedly successful is found in the many pages of "The Engineer's Guide to Success" which are filled with typical results of T.I.G.B. Students. This testimony of former Students obviously provides the soundest reason why you too may enrol with The T.I.G.B. with every confidence in the Issue

Write to-day for "The Engineer's Guide to Success" — 128 pages — containing the widest selection of engineering courses in the world, and mention the branch, post or qualification that interests you. The T.I.G.B. guarantees training until successful for the one fee.

THE TECHNOLOGICAL INSTITUTE OF GREAT BRITAIN,
76, Temple Bar House, London, E.C. 4
(Founded 1917.)

PATENTS

KING'S PATENT AGENCY, Ltd. (B. T. KING, Regd. Patent Agent, G.B., U.S., and Can.). Advice handbook and consultations on Patents and Trade Marks FREE.—146A, Queen Victoria-street, London, E.C. 4. 45 years' ref. 'Phone: Central 0662. 6266 H

PATENTS AND DESIGNS ACTS, 1907 TO 1928. IT is Hereby Notified that the OWNERS of BRITISH PATENT No. 253,041, for "Improvements in or relating to Carburetters for Internal Combustion Engines," are PREPARED to ENTER into NEGOTIATIONS with interested parties for the SALE of the PATENT and other BRITISH PATENTS relating to Carburetters, &c.—Communications please address to Messrs. DICKER, POLLAK and MERCER, Chartered Patent Agents, 20-23, Holborn, London, E.C. 1. 6827 H

THE PROPRIETORS of BRITISH PATENTS Nos. 206,932, 206,933, 206,934, 255,893, and 256,636 are PREPARED to SELL the PATENTS or to LICENSE British Manufacturers to WORK thereunder. They relate to improvements in stapling machines.—Address, BOULT, WADE and TENNANT, 112, Hatton-garden, London, E.C. 1. 6830 H

THE PROPRIETOR of BRITISH PATENT No. 227,325, dated April 30th, 1924, relating to "Improved Process and Apparatus for Disintegrating and Mixing Moulding Sand," is DESIROUS of ENTERING into ARRANGEMENTS by way of a LICENCE or otherwise on reasonable terms for the purpose of EXPLOITING the above patent and ensuring its practical working in Great Britain.—All inquiries to be addressed to B. SINGER, Steger Building, Chicago, Illinois. 6834 H

AGENCIES

NEW ZEALAND.—ENGINEER, in Early May Proceeding to, for six months, DESIRES COMMISSIONS. Good connections.—Address, P1028, The Engineer Office. P1028 D

POWDERED MICA.—Well-established AGENT REQUIRED to Represent Indian House for the Sale of Powdered Mica.—Write, giving full particulars, to Box 193, Strand House, London, W.C. 2. P1020 D

MISCELLANEOUS

DO YOU SEEK A PUBLISHER? MSS. of all kinds required for immediate publication. Advice, Lists, and Booklets of Commendation free. Established 30 years.—Messrs. STOCKWELL, Ltd., 29, Ludgate-hill, London. 5841 I

INSPECTION, TESTING and INSURANCE of ELECTRICAL and other POWER PLANT. Advice on power schemes and factory lay-outs, &c. —BM/GLDJ, London, W.C. 1. P1021 I

ENGINEERS—
We offer you the finest and most complete book on Engineering Careers ever compiled—absolutely FREE of charge. This book contains 180 pages of invaluable information and advice. It also contains details of B.Sc., A.M.I.C.E., A.M.I. Mech. E., A.M.I.E.E., A.M.I.A.E., A.M.I. Struct. E., M.R. San. I., L.I.O.B., F.S.I., G.P.O., C. and G., etc., Exams., outlines home-study Courses in all branches of Civil, Mechanical, Electrical, Motor, Wireless, Aeronautical and "Talkie" Engineering and explains the unique advantages of our special Appointments Department. WE ALONE GUARANTEE "NO PASS—NO FEE." You owe it to yourself to read our Handbook. Send to-day, stating branch or subject of most interest.
BRITISH INSTITUTE OF ENGINEERING TECHNOLOGY.
22, Shakespeare House, 29-31, Oxford St., W.1.
P1043 I

For continuation of Small Advertisements see page 4.

CLASSIFIED ADVERTISEMENTS

If you have a VACANCY *to fill,*
If you require a SITUATION,
If you want a MACHINE,
FACTORY PREMISES,
A CONTRACT,
AN AGENT,
A PARTNER, Etc.,

THEN STUDY AND MAKE USE OF THE
CLASSIFIED ADVERTISEMENT SECTION IN
The Engineer

YOUR ADVT. WILL BE SEEN BY ALL WHO ARE CONCERNED.

Gears
See large advertisement next week.
The Power Plant Co. Ltd.
WEST DRAYTON · MIDDLESEX

LOCOMOTIVE . MARINE . STATIONARY
"M.L.S."
SUPERHEATERS
To suit all requirements.
Specialists in Design and Manufacture
The SUPERHEATER COMPANY LIMITED
BUSH HOUSE, ALDWYCH, W.C. 2.

THE
ENGINEER DIRECTORY
This Directory, which is published annually in the interests of advertisers in THE ENGINEER, may be obtained free of charge on application to the Publisher.
NEW EDITION NOW READY.
28, ESSEX ST., STRAND, W.C. 2.

A Seven-Day Journal

A Year's Work at the N.P.L.

THE report issued this week on the work of the National Physical Laboratory during 1930 shows that in spite of the industrial conditions the amount of test and investigatory work carried out for payment continued throughout the year at a very high level. So much of the time of the staff is occupied on work called for from outside that there is a danger of the prosecution of pure or fundamental research being crowded out. In the Physics Department the number of tests carried out amounted to 20,243, and, in addition, 504,698 clinical thermometers were examined. In this department, excluding thermometers, the examination of radium preparations with 5774 tests headed the list, tests on telescopes to the number of 1510 coming second. In the Electricity Department 2504 tests were made, the principal item being tests on incandescent lamps, of which 681 were examined. In the Metrology Department the number of tests carried out was 14,857, in addition to which 18,227 taximeters and taximeter gear-boxes were examined. Excluding taximeters, the principal contribution to the work of the Metrology Department was made by tests on glass and other vessels for the measurement of capacity, of which 5307 were carried out, second place being occupied by tests on cylindrical gauges, of which 2526 were made. The tests made in the Engineering Department numbered 1294, the principal contribution being made by tests on the strength of materials, which numbered 956, road material tests, 99 in number, coming second, and 62 tests on standard reference jets coming third. In the Aerodynamics Department 76 tests were made, and in the National Tank 59 tests on models were carried out. One change in the staff of the Laboratory should here be recorded.

Re-lining a Water Tunnel.

IN the extension of the Tube railway from Finsbury Park to Cockfosters the tunnel has to be driven under the New River at the point where it crosses Bounds Green-road, Wood Green. Here the river is carried in a brick tunnel, three hundred years old, and as the railway will pass only 25ft. below, it was considered advisable to re-line the tunnel so that the new constructional work could be carried out safely. The work has to be done, however, without interfering with the flow of the water, which feeds a reservoir of the Metropolitan Water Board. In order to get over the difficulty, a steel pipe, 6ft. in diameter by 90ft. long, was constructed, and last Tuesday, after the ends had been sealed up it was rolled into the river, upon the surface of which it floated. It was easily towed by means of hawsers to that part of the tunnel which lies directly above the route of the railway extension. Here it is being sunk so that the river can be diverted by dams to pass through it. When the water left in the tunnel has been pumped out, the relining work will be begun. As soon as this work is completed, the steel pipe will be withdrawn and the water be allowed to revert to its old course.

A New Clyde Industry.

THE announcement is made that a new company is being formed with works in the Mossend-Bellshill area to undertake the manufacture of all classes of domestic electrical apparatus, such as radiators, heaters, stoves, and other appliances, for the making of which locally produced materials will be almost exclusively employed. Closely identified with the new company is Major Colville, of David Colville and Sons, Ltd., who is also the chairman of the Clyde Crane and Engineering Company, Ltd., of Mossend, the managing director of which company, Mr. John Jardine, is also connected with the new development. Major Colville has for some time past taken a keen interest in the welfare of the West of Scotland industry, and has been most active in his efforts to stimulate and encourage local enterprise. It is believed that the new industry will give employment to a large number of young workers, both male and female, in an area which has felt keenly the depression in the iron and steel and coal trades and changes brought about by the reorganisation of various industries in the Mossend area. It is felt that the establishing of such an industry in the Clyde area is particularly fitting in view of the low domestic rates for the Clyde Valley Company supply and the large demand for domestic electrical apparatus which in many cases is now satisfied from continental sources. The district chosen for the new works is one which is well situated for the supply of steel, non-ferrous metals, glass, and insulating materials.

The Faraday Remembrance Stone at Battersea.

ST. GEORGE'S DAY, April 23rd, was appropriately chosen for the unveiling of a remembrance stone built into the new Battersea power station to commemorate Faraday's discovery which forms the basis of modern electrical engineering. An interesting feature of the ceremony was the fact that the Governor-General of Canada, the Earl of Bessborough, spoke from Ottawa by wireless telephone, and invited the chairman of the London Power Company, Mr. William Fladgate, to unveil the remembrance stone on his behalf, the speech being made audible to a large number of visitors by means of amplifiers. In his message, the Governor-General referred to the miracle of science by which his speech was transmitted—a miracle which was in the true line of succession to those experiments begun in a laboratory at the Royal Institution 100 years ago. It was satisfactory, he remarked, that a remembrance stone had been erected in the Battersea power station on the banks of the Thames, so that the name of Faraday might be recalled in a place designed to increase the provision of light and power in larger London. After Mr. Fladgate had unveiled the remembrance stone, he used a telephone near the tablet to convey the thanks of the London Power Company to the Governor-General. Speaking at a luncheon which followed the ceremony, Mr. Herbert Morrison, the Minister of Transport, referred to the controversy which had surrounded Battersea on the question of the emission of smoke and grit, and sulphur fumes. Much research and practical work had, in consequence, been conducted, with the result that methods had been found by which sulphur emission could be reduced to a negligible amount, and thus it was possible to allow the erection of large stations in a district where the consumption of large quantities of coal under ordinary conditions would be inadmissible.

Wages in the Engineering and Shipbuilding Trades.

ON Thursday of last week, April 23rd, a conference of all the trade unions in the engineering industry took place in London to discuss the position arising out of the negotiations with the employers regarding their proposals for a revision of working conditions in order to reduce production costs. The meeting was adjourned until May 7th in order that the union executive committee might consider the proposals of both sides. On the following day, Mr. A. L. Ayre, chairman of the Shipbuilding Employers' Federation, at a joint conference of members of that Federation and representatives of the trades unions concerned in the industry, held in London, gave an outline of the present position of the shipbuilding and ship-repairing industry. That position, Mr. Ayre stated, called for sacrifices on the part of all concerned, if British shipbuilders were to regain their share in the world's shipbuilding industry. After the employers' statement had been submitted to the conference, Mr. W. Sherwood, who acted as the chairman of the unions' side, said that it would receive the careful consideration of the unions. It was arranged to adjourn the conference till the end of May or the beginning of June.

Transatlantic Air Mail.

ALTHOUGH an air mail service is operated by Pan-American Airways between New York and Bermuda, and the Aero-Postale of France runs a similar service from Europe to the Azores, there is still a gap, 2100 miles long, between Bermuda and the Azores, to be covered before the Transatlantic chain is complete. A step has now been taken towards the closing of this gap by an understanding which has been reached between Imperial Airways of Britain and the French and American concerns mentioned above. Many technical difficulties must be overcome before the long flight over the ocean can be covered in safety, and in order to operate this section of the route large flying boats of a size greater, perhaps, than any at present in existence, will be necessary. For experimental purposes the Air Ministry is having a big Supermarine Rolls Royce ocean-going flying boat constructed, which, it is hoped, will be ready for trial flights by the end of the summer. Power will be provided by six 900 H.P. Rolls-Royce engines. The boat will have a non-stop flying range of about 2300 miles, and will accommodate 40 passengers. Provision will have to be made for the carriage of several tons of mails, and it is reported that sleeping berths for twenty passengers will be included. Owing to the fact that numerous experimental and trial flights must be made on machines destined for such an important duty, the date at which the Transatlantic mail service will be opened is uncertain. It is improbable that it can come into operation before 1933 at the earliest.

The French Schneider Trophy Machines.

IN view of the secrecy with which this country, Italy, and France are making their preparations for the Schneider Trophy Contest, which is to take place on September 12th, the information regarding the French machines which the Paris correspondent of *The Times* supplied to his paper this week strikes us as being remarkably detailed. The machines now being prepared are described as Bernard, Nieuport-Delage, and Devoitine low-wing wire-braced monoplane racers, with tractor screws and twin floats. They are stated to have been designed for a theoretical maximum speed of 390 to 400 miles an hour. The engines to be used are the Lorraine-Dietrich "Radium" and a new Renault. The "Radium" engine is said to be designed to develop 2200 B.H.P. at over 4000 r.p.m., to be equipped with a supercharger running at 28,000 r.p.m., and to weigh only 0·52 lb. per horse-power. It is an inverted water-cooled engine, and is claimed to present a cross-sectional area no larger than that of the pilot's body. The new Renault engine is a vee-type water-cooled design with a maximum output of 2300 H.P., and weighing about 0·67 lb. per horse-power. The pilots for the contest are now in training at Berre, and until the new machines are ready are using older types having top speeds of from 250 to 330 miles per hour.

Metropolitan-Vickers Russian Agreement.

A STATEMENT of considerable interest, which we print below, has just been issued by Mr. Saul G. Bron, Trade Representative of the U.S.S.R. in Great Britain, and Sir Philip Nash, chairman of Metropolitan-Vickers Electrical Export Company, Ltd. It states that a technical agreement of far-reaching importance, extending over a number of years, has just been signed between the Soviet Government and the Metropolitan-Vickers Electrical Company, Ltd., under which the latter has agreed to provide expert technical assistance in the manufacture of steam turbo-generating plant, condensing plant, heavy electrical plant, industrial motors, switchgear, &c., which are to be built in Russia in the works of the All-Union Electro-Technical Combine. The plant manufactured will extend to the largest capacity required for the generation and distribution of electricity, and it will be employed in connection with the Five-Year Plan of industrial development. This is the second agreement covering the supply of expert technical assistance which the Metropolitan-Vickers Company has concluded with the U.S.S.R., the first having been in operation satisfactorily to both parties for four years.

H.M. Destroyer "Acheron."

DURING a recent exhaustive series of trials on the Clyde, H.M. Destroyer "Acheron," which is equipped with high-pressure boilers and twin-screw Parsons single-reduction, high-pressure turbine machinery, set up a new record in fuel economy for steam-propelled naval vessels. The oil fuel consumption on the full-power trial was 0·608 lb. of oil per shaft horse power for all purposes when the boilers were burning 0·785 lb. of oil per square foot of heating surface. It will be readily appreciated that the efficiency of the boilers would be materially increased at a reduced rate of fuel consumption; the high temperature of the funnel gases usual under destroyer conditions, namely, 600 deg. to 700 deg. Fah., as against the 200 deg. or 300 deg. used in recent liner practice, must also be borne in mind. The contract for the "Acheron" was placed by the Admiralty with the Parsons Marine Steam Turbine Company, Ltd., of Wallsend, at whose works the turbine machinery was constructed. The hull and the boilers were built by John I. Thornycroft and Co., Ltd., at Woolston, Southampton, and the ship was launched on March 18th, 1930. She is one of the "Acasta" class of destroyers, and has a designed speed of about 35 knots at an output of about 34,000 S.H.P., and her displacement is 1330 tons, with a length of 312ft. between perpendiculars. Her armament comprises four 4·7in. guns, two 2-pounder pom-poms, five machine guns, and eight 21in. torpedo tubes on quadruple mounts. The boilers, which are designed for a working pressure of 500 lb. per square inch and a total steam temperature of 720 deg. Fah., embody the latest Admiralty oil-burning arrangements, based on the special research work carried out at the Oil Fuel Experimental Station at Haslar. The boilers are of Thornycroft design, and include the firm's special arrangement of air heaters, superheaters, and other details.

British and Foreign Trade Statistics.

TOWARDS the end of last year the first volume of statistical tables, Fiscal Blue book, Part I., relating to British and foreign trade and industry, was prepared by the Board of Trade, and published by H.M. Stationery Office. The purpose of these tables was to supply a body of statistical information which would enable a general review to be made of the state of industry and trade at home and abroad during the preceding seven years. The second volume, the Fiscal Blue book, Part II., which has been designed with a view to a more detailed survey of particular industries, was recently laid before Parliament, and was published on Tuesday last, April 28th. So far as information was available, the more important particulars regarding production, trade, employment, and prices, both in the United Kingdom and in the principal competing countries, have been brought together. From the twenty-one groups of industries included in the tables, we would particularly mention the following, which are likely to interest our readers. They are the coal, iron and steel; engineering, other than electrical and marine engineering; shipbuilding and marine engineering; motors, cycles, and rubber tires; and electrical machinery industries. The "safeguarded" industries are dealt with in a special section, in which information regarding imports and exports and particulars with regard to the production and employment in those special industries is given.

The Effect of Use on the Properties of Motor Oils.

By S. LIVINGSTON SMITH, D.Sc., M.I. Mech. E., A.C.G.I. and E. GLAISTER, M.Sc., D.I.C., A.C.G.I.

THIS article gives a record of some experimental work undertaken wth the Deeley oil testing machine in the Mechanical Engineering Laboratory of the City and Guilds (Engineering) College, South Kensington. In addition to measuring the static coefficient of friction as originally intended by Mr. Deeley, the machine was employed by the authors in a novel way to find the kinetic coefficient. These two coefficients are a measure of certain properties of the oil tested, and they are utilised in these experiments to find the change brought about in the lubricating properties of certain motor oils when used in the petrol engine of an automobile.

THE DEELEY MACHINE AND THE AUTHORS' METHOD OF USING IT.

Description of Machine.—The machine was designed by Mr. R. M. Deeley for the purpose of investigating the coefficients of friction between contact surfaces of different metals when lubricated with various oils.

It consists essentially of two opposing friction surfaces, one, the lower, in the form of a cast iron disc D—Fig. 2—and the other, the upper, consisting of three pegs P. The disc is carried by the tray A—Fig. 1—and flooded by the lubricant under test. The

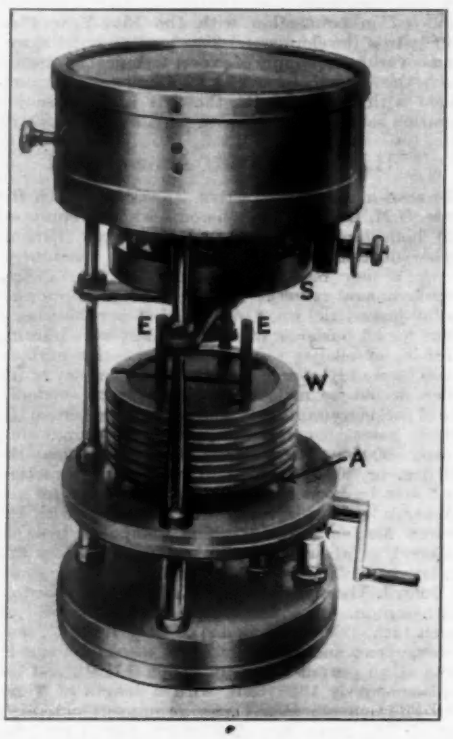


FIG. 1—THE DEELEY FRICTION TESTING MACHINE

pegs are of mild steel, $^5/_{32}$in. diameter, and symmetrically disposed in a circle of 7 cm. diameter. The carriage is centred by a spindle co-axial with the disc, and is provided with two vertical posts E—Fig. 1—which engage with the crosshead of the torque-measuring device. This consists of a coil spring S, and an indicating mechanism which records by means of a pointer on a scale the torque transmitted to the spring.

The machine is operated by rotating the tray by means of the handle shown. This at the same time rotates the disc, and the frictional resistance between the disc and the pegs causes rotation of the carriage against the resistance of the spring. Any required bearing pressure between pegs and disc can be provided by adding weights W to the carriage to which the pegs are attached.

It should be noted that in order to obtain accurate results, it is important to maintain constant surface conditions throughout. This entails furnishing an entirely new surface by an identical procedure for each test. It was found that the steel pegs showed no sign of wear, and that washing with hot water quickly removed the surface film. The cast iron disc, however, wore more rapidly. It was prepared by washing with benzol, then sprayed with hot water until the surface remained thoroughly wet all over, showing that all oil had been removed. It was then dried and carefully lapped with flour carborundum and the oil to be used. The lap, made of soft brass, is shown at L—Fig. 2. Finally, the carborundum was removed by repeated rubbing with the oil and a piece of cork, and wiping with fluffless blotting paper.

To Measure the Static Coefficient of Friction.—If the disc is rotated against the resistance of the spring until slipping just occurs between the pegs and the disc, the reading of the machine then obtained is a measure of the static coefficient of friction.

If R=scale reading and W=pressure between friction surfaces in pounds per square inch,

Then coefficient of static friction $\mu_s = \frac{R}{W} \times$ a constant.

To Measure the Kinetic Coefficient of Friction.—The authors substituted a mechanical drive for the handle H, so that the disc could be rotated at a predetermined constant speed, thus establishing a continuous and steady slip between the lubricated surfaces. The reading of the machine then obtained gives the kinetic coefficient of friction μ_K.

It was found that to obtain consistent results, the dimensions of the machine limited the rubbing velocity to about 100ft. per minute. The dimensions of the pegs and weights supplied provide for bearing pressures of from 10 lb. to 100 lb. per square inch.

Method of Heating the Oil.—An efficient control of

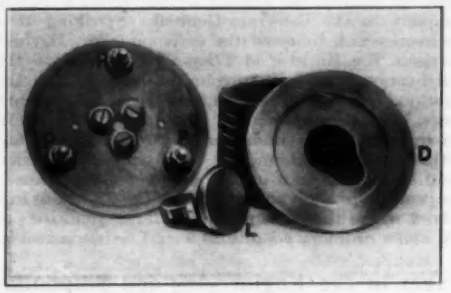


FIG. 2—FRICTION SURFACES

the temperature of the oil under test is vital, as the temperature determines the viscosity, which, in turn, affects the coefficient. The authors therefore fitted a heating coil of $\frac{1}{16}$in. diameter copper tubing under the tray. Steam or hot water was passed through the coil until a steady temperature gradient was established, and the oil was found to have reached the required constant temperature. By this means it was found possible to carry out tests at temperatures up to 60 deg. or 70 deg. Cent.

THE LUBRICATING PROPERTIES MEASURED BY THE STATIC AND KINETIC COEFFICIENTS.

It is recognised that the condition of the lubrication between two surfaces can be either "boundary" or "fluid," or some condition intermediate between them. The "boundary" condition is one which obtains when the lubricant is present only as a contamination film. The bearing surfaces are in contact, even though such contact be not actually metallic, owing to the modified surface conditions caused by the "physico-chemical union of oil and metal" (Deeley).

The "fluid" condition might be termed the ideal state, in which the film is of such thickness that the opposing surfaces never come into contact. The

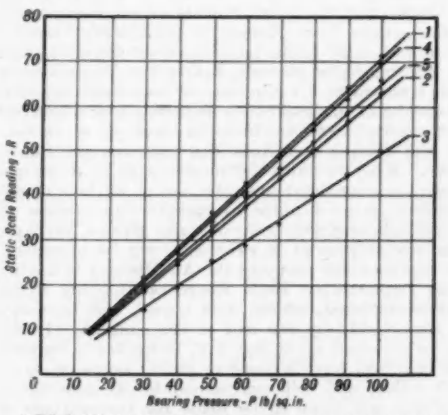


FIG. 3. STATIC FRICTION TORQUE - BEARING PRESSURE. UNUSED OILS.
"THE ENGINEER"

resistance to relative motion is then only that which is set up by the internal resistance of the oil to shear.

The differences between the two types are so great that it has been doubted whether there be any continuity in passing from one to the other. Fluid friction, according to theory, is independent of the load and of the chemical nature of the lubricant and surfaces. Boundary friction, on the other hand, is dependent on the bearing pressure between the surfaces, and so follows the same law as solid friction. It has also been definitely established that boundary friction is dependent on the chemical nature of the surfaces and of the impalpable layer of lubricant between them.

The Static Coefficient—As explained already, this is measured by the torque necessary to produce the first slip between the friction surfaces. It is clear that it is obtained under conditions of true boundary lubrication, so that the total friction should be directly proportional to the pressure between the surfaces. The results of tests on a number of oils given in Fig. 3 show that this is actually so, and Fig. 4 gives the corresponding values of the static coefficients.

As these coefficients are independent of the pressure, differences between them must be due to some property which varies from one oil to another. That it cannot be the viscosity is shown by the values given in Fig. 4. It can, therefore, only be due to the property known as "oiliness," which is the recognised criterion of the relative values of lubricants when under boundary conditions. Whence it follows that the value of the static coefficient given by the

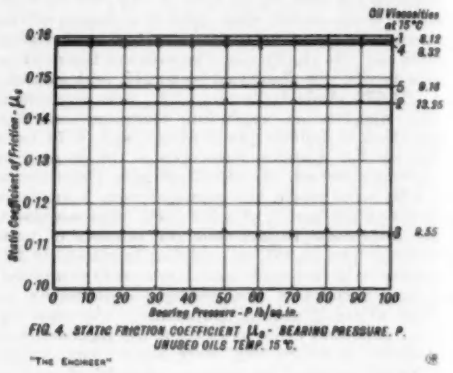


FIG. 4. STATIC FRICTION COEFFICIENT μ_s - BEARING PRESSURE. P. UNUSED OILS TEMP. 15°C.
"THE ENGINEER"

Deeley machine is a measure of the oiliness of the lubricant tested.

The Kinetic Coefficient.—This is obtained by the authors' method from the reading of the machine when a steady rate of slip is established between the friction surfaces at any desired pressure and speed. It is clear that if the pressure is low enough and the speed is sufficiently high, a fluid film will be induced between the surfaces, and the purely fluid condition will obtain. Should, however, the relative velocity be so small that the fluid film is broken down, a semi-fluid state will be created, which may, if the conditions increase in severity, lead to a definitely boundary state. The law of fluid friction is $\mu_K = \frac{\eta V}{P t}$

where η=oil viscosity,
V=relative velocity of the surfaces.
P=bearing pressure,
t=thickness of the oil film.

In these experiments, therefore, the oil viscosity, the rubbing velocity, and the bearing pressure were varied in turn, using oil sample No. 1, with the following results.

(1) *Effect of Temperature or Oil Viscosity.*—As

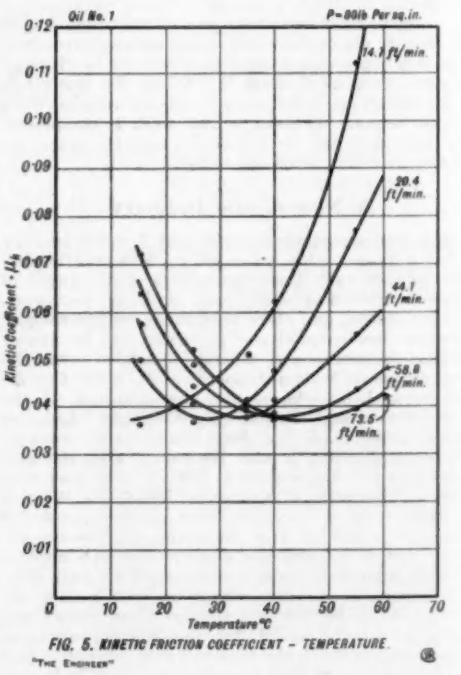


FIG. 5. KINETIC FRICTION COEFFICIENT - TEMPERATURE.
"THE ENGINEER"

previously explained, the oil viscosity could be varied by varying its temperature. Fig. 5 shows the effect of temperature on the kinetic coefficient at four different rubbing velocities and a constant pressure of 80 lb. per square inch.

It will be seen that with the low velocity of 14.7ft. per minute, rise in temperature causes a progressive increase in μ_K, but in the case of the higher velocity of 73.5ft. per minute increase in temperature is accompanied by a fall in μ_K, until it reaches a minimum value, after which it commences to rise. This minimum value is the same for all the rubbing velocities chosen, but the temperature at which it occurs increases with the rubbing velocity.

These results show the effect of temperature on

the viscous drag. The latter is reduced by increasing temperature until a point is reached when the fluid condition breaks down and is replaced by a semi-fluid, or, possibly, a boundary condition. In the case of the low velocity of 14.7ft. per minute, this has already occurred, and the whole of the curve is under semi-fluid or boundary conditions. In the other cases, the change-over point is clearly shown.

(2) *Effect of Velocity and Pressure.*—In Fig. 5, μ_K is seen to increase with the rubbing velocity when the temperature is 15 deg. Cent., but to decrease with the rubbing velocity at temperatures above 50 deg. Cent. Two sets of curves between rubbing velocity and the kinetic coefficient were, therefore,

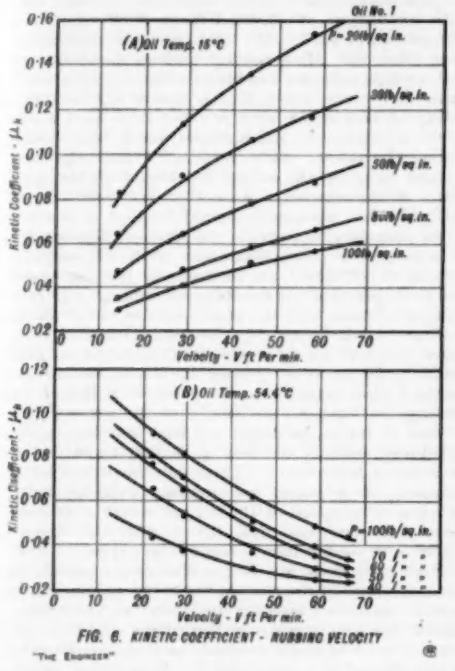


FIG. 6. KINETIC COEFFICIENT - RUBBING VELOCITY

"THE ENGINEER"

obtained, one set A at 15 deg. Cent., and the other set B at 54 deg. Cent. These are shown in Fig. 6. In each case several pressures were used.

In the case of curves A, the kinetic coefficient is increasing with velocity and decreasing with the pressure, which is characteristic of fluid lubrication and in accordance with the friction law.

Curves B entirely reverse the relationships shown by curves A. At the higher temperature the coefficient decreases with velocity and increases with the pressure. The question arises as to what state of the lubricant is responsible for these conditions. It cannot be the purely boundary state, because the coefficient is varying with the pressure, and it clearly cannot be the true fluid state, because the coefficient is falling with increasing velocity. The lubricant must, therefore, be in a state of transition from boundary to fluid.

It, therefore, is evident that the Deeley machine can be utilised to measure the coefficient of friction between lubricated surfaces when the lubricant is in the boundary, the fluid, or the intermediate state.

Having now traced the separate effects of temperature or oil viscosity, velocity and pressure on the friction coefficient, using one oil throughout, the results of similar experiments on a number of different oils are shown plotted in Fig. 7 to a common base of $\frac{\eta V}{P}$. The resulting curve is a clear proof of the reproduction in the machine of the three modes of lubrication mentioned above, and provides an excellent check on the accuracy of the experiments.

The curve evidently consists of two definite portions joined by a less definite critical point. At the right-hand end of the curve we have the purely fluid condition, which persists as $\frac{\eta V}{P}$ is reduced until a critical point C is reached. At this point the relationship between the coefficient μ_K and $\frac{\eta V}{P}$ suddenly changes, due to the commencement of a breakdown of the oil film. A further reduction in $\frac{\eta V}{P}$ is accompanied by a rise in μ_K, due to a continuance of this film breakdown. This part of the curve clearly represents the semi-fluid condition.

THE EFFECT OF USE ON CERTAIN PROPERTIES OF MOTOR OILS.

This question was investigated in two ways :—

(1) By a critical examination of the changes in the lubricating properties measured by tests on oils before and after use.

(2) By suitably treating the unused oil in order to reproduce artificially the properties of a used oil as revealed by the above tests.

(1) EXAMINATION OF THE LUBRICATING PROPERTIES BEFORE AND AFTER USE.

Five different lubricating oils, Nos. 1 to 5, were tested before use, and again on being drained from the crank cases of different automobile engines after known periods of running, as shown in Table I.:—

TABLE I.—*History of Used Oils Tested.*

Oil No.	Period of use.
1 U ..	40 hours in a 20 H.P. "Talbot" engine on test bed
2 U ..	2000 miles in 16 H.P. "Peugeot" engine
3 U ..	1000 miles in a 3·5 H.P. air-cooled "P. & M." motor cycle engine
4 U ..	600 miles in 12 H.P. "Fiat" engine
5 U ..	2500 miles in 40 H.P. "Daimler" engine.

In addition to measuring the changes in the friction coefficients, both static and kinetic, by means of the Deeley machine, tests for flash point, viscosity, and acidity were carried out.

The results of these experiments, both before and after use of the oils, are given in Fig. 8, in which the curves give the viscosities of the different oils and the table gives the other properties with the exception of the kinetic coefficient. This coefficient was measured under conditions of fluid lubrication and is shown in Fig. 9 plotted against viscosity.

Changes in the Static Coefficient with Use.—It will be seen from Fig. 8 that the static coefficient has changed only slightly, whereas the value of the viscosity at any given temperature is considerably reduced with use. Fractional distillation tests showed that this latter change was due to dilution of the lubricant by unburnt fuel.

It was considered that the small change in the static coefficient with use might possibly be due to a combination of increased acidity and asphaltic content, and reduced viscosity, any or all of which might be exerting opposing influences.

Changes in the Kinetic Coefficient.—The results given in Fig. 9 show the kinetic coefficients for all the oils tested, both before and after use, plotted on a viscosity base. These tests were carried out at a constant rubbing velocity of 34ft. per minute and at pressures varying from 40 lb. to 100 lb. per square inch. It will be seen that all the oils, both in the used and in the unused condition, fall on one smooth curve for each pressure. This is in complete agreement with the conditions for fluid lubrication previously discussed in connection with Fig. 7.

It follows that the change in the kinetic coefficient can only be due to the change in viscosity brought about by fuel dilution of the lubricant.

(2) REPRODUCTION OF THE CHARACTERISTICS OF USED OILS IN UNUSED OILS.

The above results show only a small change in the static coefficient with use. This difference may be due to the combined or separate effects of reduced

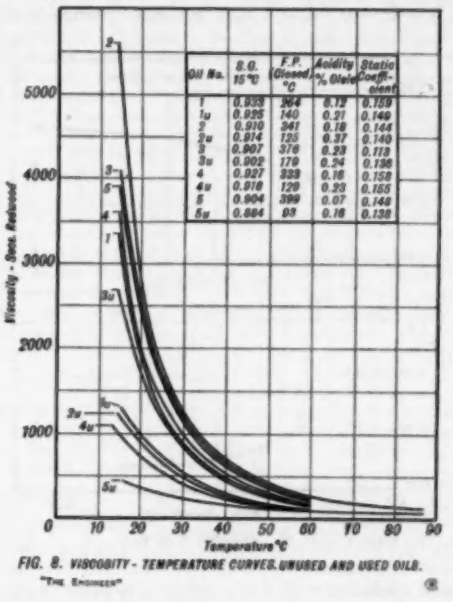


FIG. 8. VISCOSITY - TEMPERATURE CURVES. UNUSED AND USED OILS.

"THE ENGINEER"

viscosity, increased asphaltic and carbon content, and increased acidity. These effects were therefore isolated and investigated separately.

(a) *The Effect of Fuel Dilution.*—The unused oils were diluted with the same diluent to a viscosity value agreeing with that after use.

TABLE II.—*Effect of Fuel Dilution on Static Coefficient.*

"D" denotes artificially diluted oil.
"U" denotes used oil.

Oil No.	Static coefficient.
1	0·159
1 D	0·156
1 U	0·149
2	0·144
2 D	0·151
2 U	0·140
3	0·113
3 D	0·120
3 U	0·136
4	0·158
4 D	0·158
4 U	0·155
5	0·148
5 D	0·159
5 U	0·138

A diluent had to be obtained of such a nature that it would be comparable with that resulting from use in an engine. Fractional distillation tests were therefore carried out on the used oils in order to ascertain the probable composition of the diluent. It was found that a mixture of 70 per cent. petrol and 30 per cent. paraffin provided a diluent of the requisite characteristics.

Table II. gives the results of these tests. It will be seen that in all five cases the coefficient is changed but little, and not always in the same direction.

(b) *The Effect of Acidity and Asphalt.*—The actual process of oxidation occurring in an engine was reproduced artificially on oil No. 1 by passing oxygen through the heated oil to imitate crank case conditions.

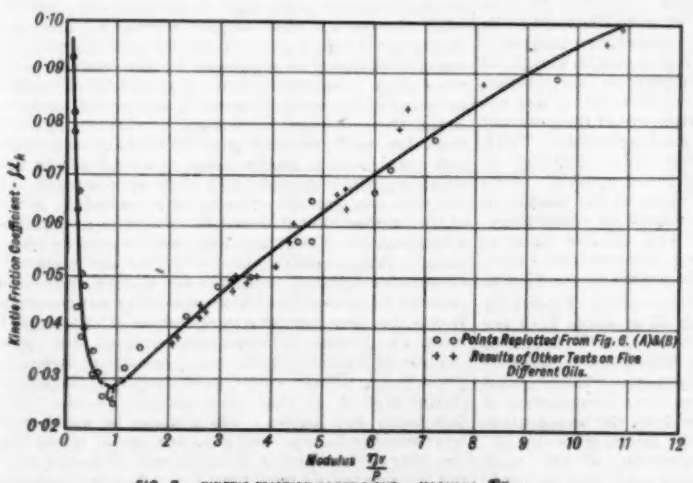

Kinetic Friction Coefficient - μ_k
Modulus $\frac{\eta V}{P}$
o o Points Replotted From Fig. 6. (A) & (B)
+ + Results of Other Tests on Five Different Oils.

FIG. 7. KINETIC FRICTION COEFFICIENT - MODULUS $\frac{\eta V}{P}$

"THE ENGINEER"

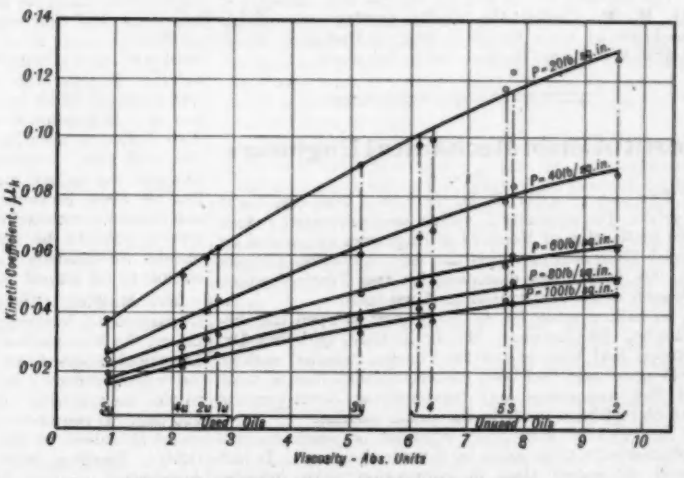


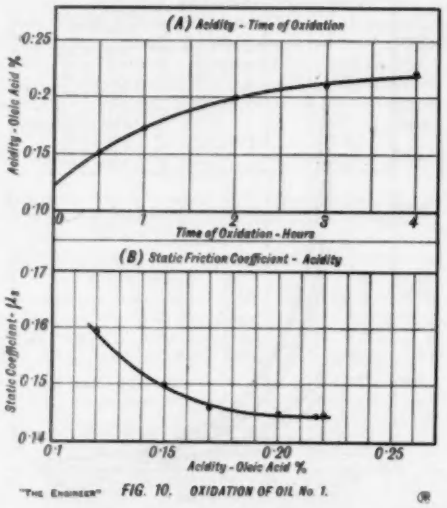
FIG. 9. KINETIC COEFFICIENT - VISCOSITY, UNUSED AND USED OILS.

"THE ENGINEER"

The curves given in Fig. 10 show that as the acidity increases with the time of oxidation there is a decrease in the static coefficient, tending towards a constant value. Again, however, the change is small.

The asphalt extracted from the used oil in the test for asphaltic content was now added to the unused but diluted oil and the changes in the static coefficient measured. The percentage reductions in the value of the coefficient for two samples were 6 per cent. and 8 per cent. respectively.

It will thus be seen that the small change in the



"THE ENGINEER" FIG. 10. OXIDATION OF OIL No. 1.

static coefficient with use is due to only slight changes in the individual factors influencing it, and not due to large changes which oppose one another.

Conclusions.

These experiments show conclusively that the Deeley machine can be used successfully to measure the kinetic coefficient of a lubricant when in the truly fluid or the semi-fluid state.

The most significant fact emerging from the examination of the used motor oils is the large decrease in the kinetic coefficient with use. This decrease is entirely due to reduction in viscosity brought about by fuel dilution. All the experiments on the changes in the other properties emphasise the relative importance of this factor.

It might be argued that the reduction in engine friction resulting from this decreased coefficient is an advantage, but it will be seen from Fig. 7 that if this reduction in oil viscosity is allowed to persist the oil film may be broken down and the life of the bearing imperilled.

It follows that efforts should be made to maintain a constant oil viscosity. Inasmuch as fuel dilution is inevitable, maintenance of viscosity can only be achieved either by removal of the diluent or by using a more viscous oil for make-up purposes.

The authors would like to express their thanks to Mr. R. M. Deeley for kindly putting one of his machines at their disposal, and to Professor W. E Dalby, F.R.S., for his interest in the work.

Institution of Mechanical Engineers.

THE paper by Mr. C. D. Gibb on "Post-war Land Turbine Development," which was presented before the Institution of Mechanical Engineers in London on April 17th, and of which the second portion appears in this issue, was discussed by the North-Western Branch of the Institution on April 16th.

In calling upon Dr. G. G. Stoney to open the discussion, the Chairman, Mr. H. L. Guy, said that Dr. Stoney had been one of Sir Charles Parsons' earliest colleagues and had been associated with him in most of the important and fundamental developments which had been made in the steam turbine.

Dr. Stoney said that engineering research was expensive, but the gains by it were also great. It had been estimated that in connection with impulse turbines the work of the Steam Nozzles Research Committee, which had cost about £8000, had resulted in a saving of some £50,000 a year in coal, or, in other words, was paying for itself every two months. Reaction turbine manufacturers had also been experimenting extensively, but it was a remarkable thing that, apart from improvements in manufacture and finish, the blade shapes now used were identical with those originally designed by the late Sir Charles Parsons in 1896 and described in his patent of that year. It was doubtful, at all events for low steam velocities, whether much improvement in the blade devised by Sir Charles thirty-five years ago was possible. In the earlier part of his paper Mr. Gibb gave alternative methods of increasing the available heat drop. The vacuum could not be increased, as it depended on the temperature of the cooling water, and it was not commercially possible to have less than about 22 deg. Fah. difference between the cooling water and the steam temperatures. The gain by raising the steam pressure was much more than that obtained by raising the steam temperature, as had been shown by Mr. S. S. Cook, F.R.S., in his paper before the North-East Coast Institution of Engineers and Shipbuilders, and as was easily seen from the entropy diagram. With effective methods of draining, which would sooner or later be developed, the loss due to wetness at the low-pressure end would be avoided, as also would be the erosion of the low-pressure blades. In any case shrouding such as that shown in Fig. 9 of the paper was effective in avoiding erosion. High pressure introduced only mechanical difficulties that could easily be dealt with, but high temperature produced troubles from expansion, creep, corrosion, &c., about which at present they knew little. Nearly all turbine troubles were attributable to temperature. There was no trouble in hydraulic machinery using high pressures without temperature. He agreed with Mr. Gibb that future development would be more in the direction of higher pressures than higher temperatures, but he doubted if reheating would become universal, the complications and cost of which were very great.

Mr. L. S. Robson (Metropolitan-Vickers Electrical Company, Ltd.) said that the paper covered much ground, but that he proposed to discuss only one point, that of disc vibration. Except for the statement that the trouble was still occasionally encountered, the author did not deal with that subject. In the associated problem of the whirling of shafts there were two methods of avoiding vibration, the use of a stiff shaft, of which the lowest critical speed was well above the running speed of the machine, and the use of a flexible shaft with the running speed lying between two critical speeds of the shaft. Properly carried out, either method would give immunity from vibration. Disc vibration might also be avoided in two ways, namely, by the use of a stiff disc, every one of the critical speeds of which lay well above the frequency of any impulses likely to be set up in the turbine, and the use of a flexible disc, with the curve of possible impulse frequencies passing between two critical speeds of the disc. The stiff disc method advocated by Mr. Baumann in his paper in 1921 before the Institution of Electrical Engineers had governed his firm's practice since that date. He could say authoritatively that no trouble had ever occurred in a turbine the wheels of which were designed in accordance with that principle.

The stiff disc method had one very big advantage, in that it was sufficient to carry out tests on stationary wheels. The influence of rotation was always to increase the natural frequency of the wheel vibration, and hence with a stiff disc the only effect of rotation was to increase the margin of safety. Further, practically any desired margin of safety could be provided, whereas if the disc were designed to run between the critical speeds, the maximum margin was limited to half the range between these speeds. In justification of the use of flexible discs, it had been suggested that the stiff disc was unduly costly, the wheels being heavier and the shaft longer and larger in diameter. To him it appeared fundamentally wrong to allow questions of cost to determine an issue involving safety and reliability. Furthermore, his experience, based on the practice of his firm for over ten years, was that machines could be designed to be profitable—even in the most competitive market—with stiff discs in which there was an ample margin of safety. It was clear that temperature distribution had a serious effect on wheel vibration, and it was not too easy to predict or to measure actual temperature distribution in the wheels of a running turbine. With the stiff disc, however, it was only necessary to increase the safety margin to avoid trouble. With flexible discs, however, an increase of the margin in one direction reduced it in the other. It would therefore appear to be necessary with flexible discs to obtain information concerning temperature distribution to an almost impossible degree of exactitude.

Mr. Midgley (Liverpool Corporation Electricity Department), referring to item 53 in Table I. of the paper, the Metropolitan-Vickers 50,000-kW turbine at Liverpool, pointed out a slight inaccuracy in the stop valve temperature. In the early stages it was intended to run the machine with a stop valve temperature of 725 deg. If required at a later date, the temperature could be raised to 800 deg., the figure given by Mr. Gibb. Dealing with the question of the most economical vacuum, Mr. Midgley said that he could endorse Mr Gibb's statement that circumstances seldom justified a back pressure lower than 1in. of mercury absolute. Concerning the size of individual units, he remarked that hitherto, in this country, the largest undertaking had had a maximum load of about 180,000 kW. One or two had maximum loads of 100,000 to 110,000 kW. Obviously, in such circumstances, units of 50,000 kW were on the large side. To install a very large machine and to have all one's eggs in one basket did not seem altogether desirable. With the coming into operation of the 1926 Electricity Supply Act things would, however, be different. Stations would be linked up and there would probably be a demand in this country for larger sets. Mr. Gibb had referred to sets running at 3000 r.p.m. He (Mr. Midgley) had discussed with various designers the question of sets running at such a speed, and they had all put forward perfectly sound arguments in favour of them. Nevertheless, he did not like them, although he could give no reasons for his dislike. He had talked the matter over with a number of operating engineers, and they had all expressed preference for sets running at 1500 r.p.m. It was a great source of satisfaction to learn how thoroughly the designers and manufacturers were going into the question of safety and reliability. From the operating point of view failure of supply was a very serious matter. Everything that a manufacturer and designer could do to improve reliability was a step in the right direction. It was particularly interesting in that respect to find Mr. Gibb so frank in his reference to failures.

Mr. Higgs-Walker (Metropolitan-Vickers Electrical Company, Ltd.) called attention to the author's remark that single-cylinder machines for high vacua with an output of 10,000 kW at 3000 r.p.m. were remarkable in 1921. Mr. Gibb might be interested to hear that the Metropolitan-Vickers Company had had a single-cylinder machine to run at that speed on order that year which had a maximum continuous rating of 17,500 kW with a vacuum of 28·4in. Mr. Gibb's reference to the increase which had occurred during the period under review in blade tip speeds seemed to carry the suggestion that high tip speeds were advantageous. Actually, however, it was desirable that tip speeds should be kept to the minimum necessary to provide the required leaving area. The fact that the Baumann multi-exhaust construction permitted an increase in leaving area of about 60 per cent. to be obtained with any given tip diameter meant that the multi-exhaust either allowed a 60 per cent. larger capacity to be handled with a given factor of safety or else that the factor of safety could be 60 per cent. greater than with the ordinary method of construction. In order to assist in completing the author's statement of the present possibilities in design, he might say that his company had developed designs for sets of 50,000 to 60,000 kW running at 3000 r.p.m. These sets incorporated two exhausts in a single low-pressure cylinder with a maximum tip speed of 1065ft. per second. It was of interest to compare that figure with the figure of 1200ft. per second mentioned in the paper.

High tip speeds, Mr. Higgs-Walker continued, were not a measure of progress in blade design, since it was possible to have a high tip speed with a short blade, in which case the stresses in the blade might be quite moderate. For many reasons, such as disc vibration, it was desirable to keep the tip diameter as small as possible, and with good hydrodynamic design of the blades it was possible to use ratios of mean diameter to blade height as small as 3·5 or 3 with good efficiency. Mr. Gibb had stated that the maximum single exhaust annulus area known to him for a 3000 r.p.m. machine was 22 square feet. He would no doubt be interested to hear that the speaker's company had now under construction a single exhaust machine running at that speed in which the leaving area was 35·3 square feet.

Mr. R. W. Bailey (Metropolitan-Vickers Electrical Company, Ltd.) said that while it was not clear from the paper whether the author had a leaning towards the use of higher steam pressures or higher operating temperatures, the general impression obtained was that if the author had a bias it was towards higher operating pressures. Inquiry in America as to the results obtained with high steam pressures left one with the feeling that serious difficulties had been encountered which had reduced considerably the commercial efficiency as expressed by the overall cost of the energy produced. Some of these difficulties had occurred in the steam generating equipment, and consequently could not be charged to the turbine. On the other hand, where higher operating temperatures had been used in recent years, it could not be said that important trouble had been encountered. As one who was primarily interested in materials, he was of the opinion that it would be unwise to assume that a temperature of 850 deg. Fah. was necessarily one at which design would probably become stabilised. Given sound design, he was of the opinion that it was possible to proceed to higher operating temperatures. It was true that even at a temperature of 750 deg. Fah. creep was present in measurable amount, and consequently at higher temperatures it became of increasing importance. There was no need to refer to the general characteristics of that phenomenon, as they were now fairly well known; but it might be worth while to remember that a very good feature of it was that the distortions which it incurred were slow and would not involve failure until very long after displacements had taken place which would be too serious to permit further operation. The question of cylinder distortion was important. From a considerable experience of plant under long periods of operation and investigation of the distortions which occurred, he was convinced that distortion was a creep effect. Consequently the extent to which distortion would develop in time was determined by the creep characteristics of the material.

An important advance, Mr. Bailey continued, would be involved if cast iron could be employed at higher temperatures than at present. In replacing steel it would not only be cheaper, but its use would have the advantage that castings could be made in the foundry of the turbine builder. When Perlit iron had been brought to the attention of engineers some five years ago his firm had made an investigation of its growth characteristics as compared with those of the normal

iron used for turbine cylinders. Specimens were submitted to steam at atmospheric pressure and 1000 deg. Fah. for eight hours during the day, and were cooled down to atmospheric temperature during the night. The tests had been made for a total heating period of over 700 hours. Measurements of length made at intervals showed that small growth occurred in both cases, with the advantage, if any, on the side of the normal cylinder iron. From these tests it was inferred that Perlit iron did not offer advantages as regarded growth over the cylinder iron used. The results, however, might have been different if the material had been under stress.

The specification governing the manufacture of turbine and generator rotor forgings given in the paper involved recognised principles. Difference of opinion and practice, however, must be expected in procedure. For example, he preferred and employed an annealing treatment instead of normalising as required by clauses 10 and 11 of the author's procedure. The reason for that preference was that it was in the interior of the forging that the most severe conditions obtained, and it was just there in the case of carbon and low alloy steels that a normalising treatment was ineffective, the reason being that the large mass of the body greatly retarded the cooling of the interior. Another point at which his firm's procedure differed from that given in the paper was the stage at which the forging was trepanned. His firm required that work to be done when the forging was first rough machined; that was before the final heat treatment and machining to final rough machined dimensions. The reason for that practice was that in a rotor forging completed from a hot ingot by a continuous procedure before becoming cold the most severe internal stresses would occur during heating up for the final heat treatment. The presence of a bore converted what would otherwise be a three-dimensional tensile stress in the axial region into a two-dimensional stress at the bore, which was a less objectionable stress system. There was an incidental advantage that the core and the bore were examined for defects at the earliest stage and if any rectification were required or defects found which necessitated rejection of the forging a minimum amount of delay was involved by the replacement. For a number of years it had been his firm's practice to trepan an axial core from all rotor forgings at the stage indicated, and to replace the core in the bore with the bore ends plugged during the subsequent thermal treatment. As a result the core became representative of the final condition of the forging in the axial region.

Mr. Norman Elce (Metropolitan-Vickers Electrical Company, Ltd.) said that the problem of erosion could be dealt with in different ways. One was that adopted by the author of providing a resistant edge in the form of a renewable shield. Another method consisted of removing a high proportion of the water of condensation by effective drainage methods. It was the standard practice of his firm to arrange for such extraction at all wet stages except at the first inception of condensation. Experiments had shown that as much as 50 per cent. of the total wetness could be removed in that way.

The author's remarks concerning the modern small turbine, Mr. Elce continued, emphasised one important characteristic of those machines—the reversion to and development of plant requiring no basement. One other important aspect of the development which had occurred in the small turbine was the method of driving the auxiliaries by direct mechanical connection from the turbine, a plan which gave a very real saving in cost and improved the arrangement, efficiency, and ease of operation. Little, if anything, had been done in that direction until it had been developed by his firm about six years ago, and it might be of interest as an indication of progress if he stated that since that time they had carried out orders for over 100 of such sets for capacities varying from 250 to 4000 kW in seven standard sizes. Mr. Elce concluded by describing his firm's design of pass-out governor for use in conjunction with small turbines from which process steam has to be extracted.

In the course of a brief reply to the discussion, Mr. Gibb sympathised with Mr. Midgley concerning his distrust and nervousness with regard to the operation of plant running at 3000 r.p.m. He pointed out, however, that rotational speed as such meant nothing, and that stress and peripheral speed were the criteria by which turbine plant had to be judged. To illustrate what nervousness could suggest, and also to show the effect of surroundings upon a running note, he remarked that all Messrs. Parsons' shafts and alternator rotors were overspeeded in a specially constructed chamber, but that on one occasion they wished to run a rotor to normal speed in an open shop for research purposes. The run up was made late in the evening and no one attending it had stopped to have a meal. It was not possible to attach a direct-driven tachometer to the shaft. A vibration tachometer was therefore held on one of the bearings of the set. At 1500 r.p.m. on the vibration tachometer the noise was exactly the same note as they had been used to at 3000 r.p.m. in the overspeed shaft house. The absence of food, together with the fact that the work being done was novel in some respects, probably made them rather jumpy. Everyone was perfectly certain that the rotor was actually doing 3000 r.p.m. and that the vibration tachometer was reading half the correct speed. Even a man brought from the balance house agreed that the rotor was running at 3000 r.p.m. Eventually some temporary gear was rigged up, and it showed without doubt that the speed was only 1500 r.p.m. The speed was then brought up, and at 2000 r.p.m. the high-pitch note previously heard completely disappeared, and it was almost impossible to hear the shaft running a few feet away from it. On reaching 3000 r.p.m. the note reappeared and was identical with that previously heard at 1500 r.p.m.

Efficiency in the Tool Department.

By G. W. TRIPP, F.C.G.I., M.I. Mech. E., A.M. Inst. C.E.

EVEN in engineering works which are otherwise comparatively well organised it frequently is found that the tool and gauge department has to a large extent been ignored in schemes of reorganisation, partly because the work is mainly performed by day-work, as distinct from piecework, and also because the one concern of the manager is production, and he fails fully to realise that the so-called non-producing departments have an enormous influence on the cost of production. A simple test of the truth of this statement can be made by taking a census of all the tools, consumable and returnable, that are scattered about in the different shops, and then estimating their value; the result will probably stagger the management and lead to a thorough investigation of the activities of the tool department, with a view to a radical saving without impairing general usefulness.

The functions of a well-ordered tool and gauge department may be regarded by many as obvious, but it should be clearly stated that the commonly accepted idea that the be-all and end-all of this branch of workshop activity is to produce the appropriate tools and gauges required for the work passing through the production departments is a very circumscribed conception, which would only lead to the fringe of an important subject being touched. Methods of tool making might be above reproach, tools and gauges might be forthcoming to meet every contingency, and yet colossal waste be piling up overhead charges in a manner that would escape detection, unless a thoroughly efficient costing system were in operation.

The department under observation must be responsible for every tool, jig, and gauge that it produces or purchases, "from the cradle to the grave," so to speak. If we accept this as axiomatic, although the scope of the superintendent is thereby widened appreciably, the tool position is safeguarded and control is placed with the appropriate branch of the organisation. Accordingly not only will the official in charge be held responsible for the manufacture of all special tools and equipment which cannot be purchased more economically, but he will also (*a*) purchase the tools required, the actual buying being, of course, entrusted to the recognised department; (*b*) store and issue all the tools, &c., necessary for production purposes, dividing them into suitable categories, *e.g.*, consumable, returnable, &c.; and (*c*) maintain all tools and gauges in a state of efficiency.

These duties involve a number of important considerations which it will be advisable to investigate before proceeding further. In the first case, if an adequate supply of tools is to be ensured, without unduly large stocks being held, some record that is readily accessible and easily followed must be maintained. It is suggested that this can best be arranged by means of a simple card index, each tool in the store having a card allocated to it. A form of card which has proved satisfactory is shown in Fig. 1, which is practically self-explanatory. Although a large number of tool departments are content to work on a maximum-minimum basis, it is felt that it is far better also to have a definite ordering level. Naturally, the maximum stock should never be exceeded, but it is also desirable that the minimum should normally be held in store, and too frequently, when only the upper and lower limits are indicated, ordering does not take place until the minimum is reached. The ordering level should be based on the consumption anticipated during the time lag between ordering and receiving the goods into store, inspected, and ready to issue. The numbers decided upon for maximum and minimum can only be determined in the light of experience, and may have to be modified from time to time, especially in the early days after the inception of the scheme.

CARD NO.: | DESIGNATION OF TOOL, JIG, etc. | MAXIMUM NO.: MINIMUM NO.: ORDERING LEVEL

ORDERED.		PLACED IN STORE.		WITHDRAWALS.		STATE OF STORE.	
Date.	Number.	Date.	Number.	Date.	Number.	Date.	Number.

FIG. 1—THE TOOL STORE CARD

Assuming that the manager of the tool department is fully alive to his responsibility for keeping the tool store supplied, the question arises as to the origin of the stock to be provided, whether it shall be obtained by internal manufacture or by external purchase. It must be realised in this connection that the tool department is an interested party, in that it naturally desires to have an abundance of work for those employed inside its own organisation, and no better means can be found than by manufacturing for stock, but it should be confessed unreservedly that it is prone to be very expensive. For this reason alone, quite apart from any others that might be advanced, it is strongly urged that the actual placing of orders for tools, &c., ought not to be a function of the tool department. Tools should be purchased in exactly the same way as any other stores which are an aid to production. While allowing that the manager of the tool department is the one best able to specify requirements, it is desirable that he should send his demands to the general stores department, which will obtain the articles required either by internal manufacture or external purchase. Quotations will be obtained from the tool department exactly as if it were outside the organisation, and only if it seems an economically sound proposition should it be given the order. Once so placed, it will be the responsibility of the tool department to see that the price quoted is not exceeded. This consideration naturally introduces the vexed question of whether piecework can be applied to tool manufacture or not. Where it has been used on stock orders it has proved an unqualified success, and has been of great assistance in helping the tool maker to keep within the estimate. It will, however, probably be found advisable to discriminate between cutting tools, which may be regarded as consumable, and jigs and fixtures, which by comparison are not. To produce jigs, which are normally turned out as single units, by piecework methods does not commend itself as a sound proposition, for it is liable to degenerate into a form of more expensive daywork. If payment by results is deemed advisable, one of the premium systems could be used more advantageously than straight piecework.

This, however, may be regarded as a digression, and we will do well to proceed to the other alternative, *i.e.*, when the tools are purchased. Although the tool department should not decide where the order is to be placed, it is recommended that tenders should be passed to it for criticism and to obtain an expert opinion and advice, particularly if it is considered desirable that the lowest tender should be passed. This procedure may lead to disagreement between the buyer and the tool department, in which case the decision should be made by the general manager, after considering both sides.

While the foregoing may be regarded as a satisfactory normal policy, it should not be followed slavishly, for it would obviously be unsound to purchase, if by so doing tool makers would be slack and the works on-cost enhanced by such idleness. In some cases it might even be legitimate to place the order with the tool department, when the prime cost was greater than that of external purchase. The most important consideration is that all the facts should be fully known to the management, so that whatever steps are taken it is with the eyes open to the situation as a whole.

Having established a simple method of replenishing the tool store, the next question to be considered is the manner in which tools should be released to enter upon their life work. It may probably be assumed that the promiscuous issue of tools to all who may demand them is rightly a thing of the past, although even now certain cutting tools are obtainable far too readily, particularly the ordinary standard lathe tool. Why the release of a comparatively cheap tool, such as a small twist drill, should be carefully safeguarded, and yet the far more expensive lathe tool be given out freely on demand, is one of those anomalies likely to remain a mystery.

If, in the first place, it is assumed that instructions are issued to the tool stores that no articles are to be issued without definite authority, it is necessary to determine the most appropriate method of giving that authority. For this purpose it is desirable to subdivide the contents of the tool store into main categories:—(*a*) Consumable, (*b*) returnable, and (*c*) exchangeable. The line of demarcation between these classes is somewhat difficult to define logically. Each works must decide into which class each tool is to be relegated, even if in some instances it has to be done in a purely arbitrary manner.

Consumable Tools.—Consumable tools are those that once issued are not intended to find their way back to store. Once fixed in a machine they will remain there until worn out, *e.g.*, a grinding wheel. A variety of stores for shop use will also naturally come into this category. These should only be issued when a recognised voucher, signed by the foreman, has been duly presented. A suitable form is shown in Fig. 2. These vouchers should be inserted in a receptacle placed in or near the bin in which the particular article is stored. This will prove a valuable check

on the entries on the tool card—Fig. 1. Incidentally, it may be mentioned that it is desirable to have the maximum, minimum, and ordering level displayed on the bin as another visual check on the card index.

Returnable Tools.—Passing on to the tools that have been designated "returnable," there is no valid reason why all lathe tools, drills, milling cutters, taps, dies, &c., should not be embraced in this category. The operator presents either a card or brass check bearing his name or number to the storeman, who deposits it in the bin from which the required tool has been withdrawn, or if this is not practicable, hangs it on a hook as close to the bin as possible. The number of tools remaining in the bin, plus the cards—or discs—should always tally

Tool Order Counterfoil.		Order for Tools, Etc. Shop: ..... Please supply the following:	
Nature.	Number.	Nature.	Number.

Order .....
Date .....

To be booked to ..... (State order number).
(Signed) ..... Foreman.
(Date) .....

FIG. 2—ISSUE VOUCHER FOR CONSUMABLE TOOLS

with the number on the tool card. In order to limit the amount of idle capital represented by tools out of the store and in the shops, but not actually in use, it is desirable to limit the number of checks allotted to each operator, and six should be an ample allowance. It may perhaps be argued that if this rule be rigidly applied, a driller who is engaged on a great variety of jobs may have to make a number of visits to the store, and in the course of a week the amount of unremunerative time may become quite appreciable. As a *via media*, and without prejudice to the general principle, it is suggested that a first equipment may be issued to each machine, comprising what has been agreed upon as the standard. This will have to be maintained in a state of efficiency by the operator, replenishments being made by means of a foreman's order. Special requirements will be satisfied by means of his checks.

Exchangeable Tools.—Exchangeable tools have qualities which may be regarded as applicable in some respects to both the preceding classes. As a simple example may be cited the ordinary file which usually remains in the service of an individual fitter until it is so far worn that no more useful work can be obtained from it. On casual inspection it would not look very different from what it did on the day it was issued, its weight and size would be virtually the same. If the fitter were allowed to exchange the worn file for a new one without any safeguard, it can unhesitatingly be stated that many only half-worn files would find their way back to store. A method that has the merits of simplicity and that has also proved successful is to insist on an order slip for a new file being obtained from the foreman who also inspects the old file which must accompany the voucher to store. In passing, it might be mentioned that some foremen are too cautious, and that though it might be perfectly true that "there's life in the old thing yet," a point arises at which the cutting effect is so materially reduced that it is no longer a paying proposition not to replace it.

If a returnable tool is badly treated or broken, the storeman should be empowered to refuse to return the borrower's check without an order slip from the foreman, thereby temporarily changing the designation from returnable to consumable. By this means the stock is kept in good condition. Every tool is examined on its return, and is ground or otherwise reconditioned before being restored to its bin.

The mention of grinding raises the important issue as to whether this work should be done exclusively by the tool department or on grinding machines set up in the different machine shops, and available for the use of machinists. There is not much doubt that many an expensive tool has been ruined by amateur grinding, and this has led to managements decreeing that no grindstone should exist outside the tool department. On the other hand, it is indisputable that many expert turners prefer to touch up their own tools, claiming that thereby they obtain better results. The Englishman's love of compromise is perhaps responsible for the arrangement adopted in many works of allowing flat cutting tools to be re-ground in the shops, but insisting on circular tools—*e.g.*, milling cutters, hobs, drills—being invariably returned for the purpose. The situation is, however, somewhat modified by the increasing introduction of expensive high-speed cutting alloys, such as widia, carboloy, &c., which can be very wastefully ground, and it would probably be a wise step boldly to establish a general rule that all cutting tools be returned to store when grinding becomes necessary.

Jig production is essentially a function of the tool department, but in the normal way the incidence of the charge is different, for whereas most tools can only be treated in a general way and charged to the shop actually using them, or by proportional assessment in some arbitrary manner which spreads them over the various departments, jigs should normally be a definite charge on the customer. Special tools made exclusively for one order should similarly be costed to that order.

As the well-being of a manufacture depends very largely on the rapid production of the jigs and tools, a few words on this important activity may not be out of place. Immediately the order is booked the jig and tool draughtsman, in co-operation not only with the tool department, but also the machine shop, should proceed to the design of the jigs with the utmost despatch, every available draughtsman being pressed into the service. When the design has been approved, it is passed to the tool room with a jig order card pinned to it, this card being the authority to the foreman to commence manufacture. It is illustrated in Fig. 3, which needs no explanation.

Card No.:	Jig, Tool or Fixture for (Name of article for which jig, etc., required).	Works order No.: Article ..... Jig .....

Drawing No. of Jig, etc. .....
Material Nature .....
Where obtained .....
Date Passed to Tool Department .....
" Work initiated .....
" " completed .....
Notes: .....
.....
.....
.....

FIG. 3—THE JIG ORDER CARD

It is intended to be the life history of the jig, being designed to incorporate relevant information which will be very valuable if put to a proper use. As soon as the actul work is initiated, the card is given to the operator, and on the reverse side will be logged all the time spent on the work, so that a rough estimate can be made of the cost of the jig, a valuable check on the time allowance of the official estimate. At the same time that the jig card leaves the office a small tally card is entered up and put in a rack reserved for jigs in process of manufacture, where it will remain until the original card is returned to the office on the completion of the work, at which time the tally card—Fig. 4—will be transferred

Jig No.:	Jig for:	Works No.:	
Date of			
Receipt of Drawing.	Receipt of Material.	Commencing Manufacture.	Completion.

Notes on delays, etc. .....
.....
.....
.....

FIG. 4—THE TALLY CARD

to the finished work rack. A third rack for work under suspension is sometimes found useful, in that it keeps the foreman alive to the fact that the work is not progressing. All the cards appropriate to a works order are kept together and in numerical sequence, so that it becomes an easy matter to tell the machine shop foreman how many jigs are completed, in hand, or not yet started, without having to rely on memory or a visit to the shops. Of course, the personal knowledge of the tool foreman as to the amount of work done on jigs, &c., in process is invaluable.

From a casual inspection of the cards in the different racks, a quick estimate can be made of the jig position on an order. The information incorporated on the various cards will be a valuable asset to the production department in arriving at reliable promises for the completion of the work.

As it has been shown to be desirable to discriminate between the different classes of tools, in the same way it will be found advisable to divide jigs into two main groups—(*a*) those that are made primarily for a specific order, and which, accordingly, can legitimately be charged to a customer's order, and (*b*) those that are used in connection with a standard product, and which may, therefore, be used for a number of different contracts.

Obviously, in the first case, the jig should be returned to the store when the work is completed, the management deciding whether it shall be scrapped at once or retained on the chance of further orders, or the possibility of spares being required. The accumulation of a large number of jigs in this category is to be deprecated.

The jigs in the second class may be issued in exactly the same way as returnable tools, on the check system, which has the advantage of ensuring their periodic return for calibration.

Gauges, though essentially different as to their function from either jigs or tools, may yet be treated in exactly the same manner as regards manufacture, purchase and distribution. Naturally, they are placed in the "returnable" category, the rules regarding return to store being very rigidly enforced, as a defective or worn gauge may soon be responsible for serious financial loss. Inspection gauges should always be kept quite separate from manufacturing gauges and should only be issued to accredited inspectors.

Though the principle that all stores issued on the check system, whether tools, jigs or gauges, shall be returned to store is one of universal application, the frequency of their return can only be determined with due regard to the many circumstances involved. In a number of cases it is found that a weekly return is both desirable and practicable; but in others a monthly interval has proved satisfactory. It should be a *sine quâ non* that every unit must be carefully examined on its return, and should only be restored to its appropriate bin after ascertaining that it is in good condition and fit for re-issue. As has already been mentioned, in the event of abuse or serious damage, the check will be refused until after the matter has been brought to light and investigated.

In a large works it is often found that one central tool store is a physical impossibility, as it would result in too much lost time due to men having to walk long distances to reach it. To obviate this difficulty, the usual resource is to have a number of departmental stores. Their introduction, in removing one source of loss, may easily bring about another. Too frequently, it is found that the departmental store is placed under the administration of the production department in which it is situated, and stocks will be built up to suit local requirements, without reference to the central tool department. This is fundamentally unsound, and it cannot be too strongly emphasised that every departmental store must be regarded as an integral part of the central store, and under the control of the tool department. By this means alone will the amount of idle capital represented by tools, &c., not actually in use be kept to a minimum.

Not nearly enough has been done in the direction of standardising tools, and thereby again reducing the amount of stock held. This is probably due to a lack of liaison between the design, the tool and the manufacturing departments. In the first case, it is desirable to meet in conference and agree upon a standard tool list which will be worked upon, then future designs will be made with an endeavour to avoid the introduction of other than standard tools. In those rare cases when it is deemed expedient to manufacture special tools, this course will only be resorted to after the representatives of the three interests have mutually agreed as to the necessity. It is suggested that a simple measure of this sort will lead to many economies in tool production, which will also exercise a direct influence on the gauge problem.

Although the tool department is rightly divorced from the manufacturing departments, there is no reason why its resources should not be utilised on special occasions. Where no special experimental branch exists, the tool department is undoubtedly the best equipped to undertake this activity, the high class of mechanic normally employed there being a valuable asset. If the building of a new type of product, on which experiment or development work is likely in the process of its evolution, is entrusted to the tool department, experience will be gained which will be invaluable when the work is standardised and put into production. The knowledge so acquired will greatly assist in an intelligent manufacture of the ancillary equipment that will then be required.

Certain precision grinding and high-class work that may from time to time be required by the millwrights in connection with the repair of high-grade machine tools can well be entrusted to the tool department.

In conclusion, it is urged that a well-organised and efficient tool department will soon justify its existence, and prove of inestimable value to the modern engineering works.

SOME idea of the anxieties of the water supply engineers of South Africa may be gathered from the fact that a furrow 900 yards long has been made in the catchment area of the Gibson dam, which supplies Harrismith with water. This furrow will divert into the dam some two millions of gallons of water a day. The last time that the dam was emptied it took four years to refill, but now it is hoped to fill it every year.

Post-War Land Turbine Development.*

By C. D. GIBB, B. Eng., Member.

(*Continued from page 466.*)

Erosion.—One limit to exhaust output which has become apparent in recent years unless reheating is adopted, is an unexpected one, namely, that due to erosion. This is the eating away of the final row of blades by their impingement at high velocities on the almost stationary water particles. The results of this action are often very remarkable.

A machine operating at an initial pressure of 450 lb. per square inch with a total steam temperature of 750 deg. Fah., and exhausting to a vacuum of 29in. of mercury, will have approximately 10 per cent. of the total fluid passing through the last row in the form of water, unless reheating or some form of draining is adopted. These conditions, coupled with really high blade-tip speeds, form a very serious problem which has been taxing the turbine designer's ingenuity to the utmost.

Erosion is affected by blade-tip speed, absolute back pressure, presence of air or other non-condensable vapour, wetness factor of steam, form of blade and blade material, while certain characteristics of the preceding guide blades also require careful consideration. Other factors being constant, the lower the back pressure the greater the effect of erosion since the cushioning action at high vacua is less pronounced. Erosion increases very rapidly with increase of blade speed, and while a tip speed of 800ft. per second may not call for any special precautions, on reaching 1000ft. per second a drastic remedy is demanded.

Erosion is most rapid in the first few hours of running and may be quite alarming, but the action soon slows down and for present-day average steam conditions with mild steel blading and a maximum tip speed of 800ft. per second, a blade life of, say, five years' continuous running should be obtained. Higher steam pressures and blade speeds necessitate the application of a preventative

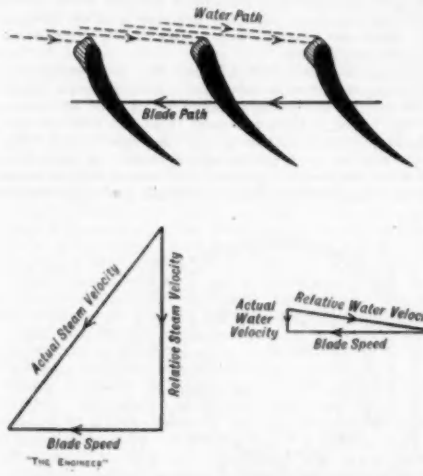


FIG. 9—LEADING EDGE OF REACTION BLADES

which may take the form of an attempt to drain the water particles, or the provision of special blading material which resists erosion to a greater degree than mild steel or stainless iron, &c. Many methods of draining have been adopted by various turbine manufacturers with varying degrees of success.

The complete removal of the condensed steam would appear to be impossible, and the final solution will probably be the combination of draining and erosion-resisting blading. The larger water particles do not follow the steam path, but tend to be thrown to the outer circumference of the steam annulus, thus assisting the draining problem, but that draining cannot be completely successful is shown by the fact that the maximum erosion attack does not necessarily occur at the blade tip, but, roughly, from ¼in. to 2in. down from the tip. The author has not heard of a complete explanation of this phenomenon, but it would seem to depend on the upstream steam path. Owing to their much lower velocity the water particles concentrate ahead of the moving blades and the resulting globules of water are hit by the blades at high relative velocity.

The problem of blade erosion is one which is equally troublesome to both impulse or reaction turbine designers, and, although, in general, the visible effect of erosion is rather less in the case of the impulse machine, the effect on efficiency is very much greater. In fact, as erosion only attacks the leading or entering edge of the blade, efficiency is unaffected in the reaction turbine, since the blade efficiency is determined by the leaving edge, and it is only when the blade strength is seriously impaired that renewals need be considered. On the other hand, the shape of the impulse blade at entry is such that the water particles meet the blade on a surface approximately at 45 deg. to the water path, while in the normal reaction shape, the water particle strikes a plane normal to the water path with consequent increased erosion.

It has been demonstrated that the shape of a reaction blade leading edge has little or no effect on the blading efficiency, and this allows the problem to be attacked in a very simple manner, since the shape of entry can be varied within wide limits without affecting the efficiency.

The author's firm now adopt a special shape for the leading edge of their exhaust-end moving blades and protect this edge with a renewable shield of specially resistant material. The shape of the leading edge is shown in Fig. 9, from which it will be seen that the water particles strike the blade on a plane approximately 45 deg. to the relative direction of movement.

* The Institution of Mechanical Engineers, April 17th, 1931.

Extensive researches carried out at the works with which the author is connected, have shown that 18 to 22 per cent. tungsten tool steel is very resistant to erosion, but it must be pointed out that this material, for fairly obvious reasons, is wholly unsuitable for making the complete blade. For moderate blade speeds austenitic alloys, such as "Hecla," "Staybrite," "Anka," &c., are quite satisfactory, and have been used in commercial machines with considerable success. Provision is also made for partial drainage ahead of the last stage, and it is confidently believed that a solution to the erosion question is found by a combination of drainage, leading edge blade shape and renewable shield material.

The preventative for erosion once having been found, blade speeds will probably increase, and this will entail the use of very high-grade alloy steels for the final moving blades and discs, whilst the turbine designer will look to the steel makers and forgemasters to accept even more stringent conditions than the already onerous specification with which they have now to comply.

MATERIALS OF CONSTRUCTION.

Every engineer associated with the electrical power industry knows how important are the words "continuity of supply," and the designer must consider reliability even before efficiency. To this end specifications are rigidly enforced and call for better-grade materials, while the metallurgists and materials test staff become very important members of a turbine works organisation.

Forgings.—Sound shaft and disc forgings for large machines are of supreme importance, and a very notable advance in the steel maker's art has recently been made possible by a new method of casting steel ingots.* Appropriately enough, this development is largely due to the pioneer of the steam turbine, the late Hon. Sir Charles A. Parsons, and is the result of the turbine makers' demand for larger and better forgings. The failure of the turbine shaft of a 20,000 kW machine at Shanghai in 1923 was entirely due to a forging fault, and resulted in much valuable research work being carried out to improve materials. This is reflected in present-day forging specifications and has contributed in no small measure to the safety of recent large designs.

The rigid control of the manufacture of forgings for turbines and rotors from the pouring of the ingot to the final heat-treatment of the rough-machined forging is regarded as being of such importance that, in the absence of an equally complete British Engineering Standards Association specification, that adopted by the author's firm is given in full below :

Specification to Govern the Manufacture of Rotor Forgings for Turbines and High-speed Alternators.

(1) The method of producing the steel must be similar to that adopted in the making of high-class material for special Admiralty purposes, and the material must be treated on similar lines to guns and other high-class alloy steel forgings.

(2) The ingot after casting must only remain in the mould for the time which experience has demonstrated is essential to allow the centre to become solid—in any case the temperature of the ingot on the outside must not be below 600 deg. Cent. It is then to be lifted and charged as quickly as possible into a furnace, the temperature of which does not exceed 600 deg. Cent.

(3) The complete ingot, plus 6in. to 12in. of the head, must be charged so that the body can be "bloomed" and "roughed down" in one heat.

(4) In heating for forging, the ingot must be raised uniformly and gradually to 700 deg. Cent., so that the expansion due to heating may be gradual. When the temperature is uniform at 700 deg. Cent., it should be raised gradually to 1200–1220 deg. Cent., and kept at this temperature for six hours before drawing for forging.

(5) If the operation covered by paragraph No. 3 has made the forging too long to be charged completely into the furnace for heating up prior to further work, it must be completely charged into an annealing furnace, the temperature of which is about 550 deg. Cent., heated to a uniform temperature of 620 deg. Cent., cooled down to below the "Ar. 1" point, and kept at this temperature sufficiently long to permit the centre of the mass attaining the same temperature—this time will be approximately 15 min. per inch of thickness. Then reheated to 660–680 deg. Cent. if the carbon content is less than 0·23 per cent. and 640–660 deg. Cent. if the carbon content is above 0·23 per cent., and kept at this temperature for six hours' softening.

(6) When the softening has been properly carried out, the bottom end of the ingot must be recharged hot into the forging furnace, the temperature of which does not exceed 600 deg. Cent., heated up uniformly to 1200–1220 deg. Cent., and forging at this end completed.

(7) After the first end is completed, and to prevent stresses being set up by differential cooling of the various sections, the forging must again be completely charged into an annealing furnace and treated as described in paragraph No. 5.

(8) When the forging has attained 620 deg. Cent., it is lifted and the unforged end charged into the forging furnace, and completed as described in paragraph No. 6.

(9) When the forging is completed, it must be taken direct to the treatment furnace, the temperature of which when the bogie is drawn, does not exceed 560 deg. Cent., charged on the bogie, allowed to stand one hour, then lifted and turned upside down, so that the top side becomes the bottom, and again allowed to stand for one hour. The forging must then be charged into the furnace at the rate of 6in. every 15 min. until completely charged.

(10) The forging must be heated uniformly to 600 deg. Cent., then cooled in the furnace to 480–500 deg. Cent., kept until the mass has uniformly attained this temperature, then raised slightly above the "Ac. 3" point, and kept the necessary time, drawn, and allowed to cool in air till magnetic. The smaller sections must be covered so as to retard their cooling, and as far as possible to permit of uniform cooling of the mass.

(11) When the forging is strongly magnetic all over, it must be recharged into the furnace, the temperature of which is about 500 deg. Cent., and heated to the temperature below the "Ac. 1" point, kept the proper length of time at this temperature, then cooled in air, observing the same precautions when cooling as described in paragraph No. 10. The temperature below the "Ac. 1" point will be determined by the composition of the steel and the required mechanical tests.

(12) The forging must then be rough-turned, and after turning charged into a cold furnace, and gradually raised to 560–600 deg. Cent., as required to give the mechanical tests. It must then be cooled in the furnace.

(13) When the size of the hole permits, the forging must then be trepanned and chambered where possible.

(14) If the design does not permit of trepanning, the hole must be bored through the shaft and chambered where permissible.

(15) The hole, when finished, must be as smooth as possible to facilitate examination by means of a borescope.

(16) If, for any reason, any of the above conditions cannot be carried out, the proposed alterations must be submitted for our approval before proceeding with the work.

Note No. 1.—Paragraphs Nos. 5, 6, and 7 of this specification refer only to forgings which are too long to be completely charged into the furnace.

Note No. 2.—The quality heating specification in paragraphs Nos. 10, 11, and 12 must be carried out in furnaces designed to heat by radiation only.

The following information must be supplied by the manufacturer of the forging :—

(1) Time and temperature of the working of the charge.
(2) Analysis of melted charge, *i.e.*, C, Si, P, Mn, S, &c.
(3) Before final additions, composition of slag and metal.
(4) After final additions and before tapping, composition of slag and composition of metal.
(5) Temperature of metal running into ladle.
(6) Temperature of metal running from ladle into mould.
(7) Dimensions of the ingot mould.
(8) Time taken from commencement of running into mould until metal enters head.
(9) Time from finishing teeming to mould stripped.
(10) Time from mould stripped to ingot charged into forging furnace.
(11) Temperature of forging furnace prior to charging ingot.
(12) Report on surface condition of ingot prior to charging.
(13) Heating for forging.
(14) Time for working each heat and records of condition.
(15) Report re working steel and surface condition.
(16) Time for finishing forging work.
(17) Temperature records during the various heat processes.
(18) Machine shops' report during rough machining.
(19) Machine shops' report during trepanning.
(20) Final examinations report.

Parsons forgings for turbine shafts and alternator rotors must also comply with the mechanical tests corresponding to the British Electrical and Allied Manufacturers' Association Grades I. or II., as may be specified.

Turbine discs are generally ordered to meet special mechanical tests, and exhaust end discs may have an

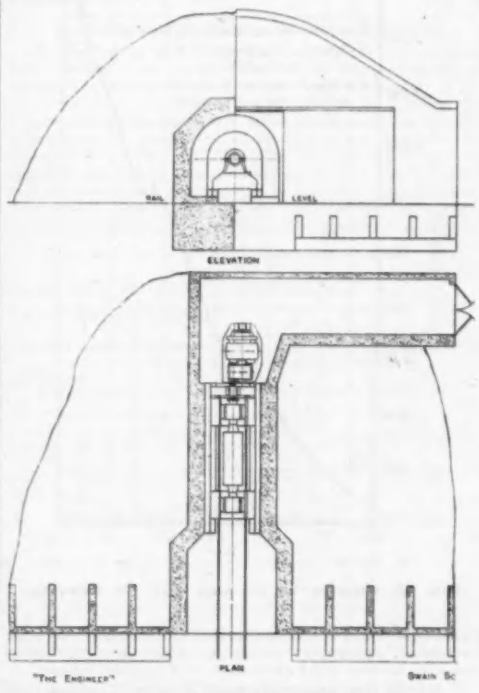


FIG. 10—OVERSPEED TESTING CHAMBER

ultimate tensile strength of 45 to 50 per tons square inch, and are made from alloy steels. Equally rigorous control of the whole manufacturing process is maintained for discs as for main forgings, but the ingot is allowed to cool for slicing.

Further tests are carried out when the forging reaches the turbine makers' works, and the practice at Heaton Works is to overspeed the unbladed rough-machined shaft or disc in a specially constructed chamber, the test speed generally being 1¼ times normal speed. In the case of discs the overspeed is carried on until the eye of the disc actually opens out and takes a slight permanent set. This leaves the material at the inner bore in compression when the disc is stationary. It is of interest to note that this method of overspeeding discs for turbine work was introduced commercially in 1905, and has been in regular service ever since. The method was patented a few years ago, doubtless in ignorance of the fact that it was already established practice. The disc is shrunk on to the shaft

* *Journal*, Iron and Steel Institute, 1929.

after final machining, thus applying tension to the eye, so that before the disc can become loose on the shaft the rotational speed must reach a point such that the tensile stress set up by rotation exceeds the tensile stress due to shrinkage.

Some details of the overspeed test chamber used at Heaton Works may be of interest, and Fig. 10 gives details of the construction adopted. The wall of the chamber is composed of heavily reinforced concrete 3ft. thick, which is then covered with earth of a depth of 15ft. to 18ft. The control of speed is carried-out from a special substation some 150ft. distant from the chamber itself. When carrying out research tests to destruction, no operator is in the overspeed chamber, and remote control instruments enable perfect safety to be attained.

A plan view of the chamber shows that the actual shaft being tested is carried in the long length of a letter L, while in the short length and at right angles to the shaft, the controls and signals to the sub-station are arranged. By this means the ordinary routine overspeed tests on turbine shafts and completed alternator rotors may be performed with the operators in perfect safety, and since reasonably accurate balance can be obtained before the overspeeding is attempted it is not necessary for the operator to go into the tunnel proper alongside of the running shaft until the overspeed has been performed and return to normal speed is reached.

Little or no difficulty is experienced nowadays with shafts or discs during overspeeding, but there has been one occasion when a disc became definitely oval at both rim and bore during the stretching operation.

Steel Castings.—Turbines operating on relatively low steam pressures and temperatures may have their casings almost entirely of cast iron, but experience has shown that for temperatures in excess of 450 deg. Fah. cast iron very quickly becomes unsuitable due to growth of the material and consequent serious distortion. Steam chests and all parts of the turbine casing which will be in contact with steam at a temperature of about 450 deg. Fah. or over are now almost universally made from a steel casting, and the production of very large sound steel castings is a problem of the greatest importance owing to the increase in both pressure and size of modern turbines. Intricate core work introduces segregation difficulties which are only overcome by accumulated experience and patient research.

A typical physical specification for a steel casting is as follows :—

Ultimate tensile strength, 27–32 tons per square inch.
Yield, 50 per cent. of ultimate strength.
Reduction of area, 45 per cent. minimum.
Elongation, 25 per cent.

Bend test, $\frac{3}{4}$in. × 1in. test piece to bend at an angle of 160 deg. over 1in. radius.

The casting is to be cleaned before annealing, and after heating to 920 deg. Cent. is to be allowed to cool in the furnace and not to be removed until cold. After rough machining the author's firm again anneal in a totally enclosed furnace to a temperature at least 50 deg. Cent. above the maximum steam temperature to be experienced in service.

For steam temperatures up to, say, 850 deg. Fah. the steel casting of the low-carbon variety is considered quite satisfactory, provided care is taken in the design to keep the stress below the safe limit for the material, but when considering temperatures above 900 deg. Fah. it will be necessary to employ alloy steel castings, and from the information at present available it would appear that the addition of molybdenum is of beneficial effect in increasing the limiting stress at high temperatures, but further work is necessary before alloy steel castings of the sizes required for very large machines can be adopted.

Iron Castings.—With large iron castings experience in moulding is also of paramount importance, and the work of the Cast Iron Research Association has enabled big improvements to be made in the physical properties of the cast material. As previously mentioned, cast iron is to-day not used for parts of the turbine where the temperature may exceed 450 deg. Fah., owing to difficulties experienced with the growing and disintegration of the metal. Lanz Perlit iron does not grow at maximum steam temperatures in small castings, but it is understood that difficulties have been experienced with this metal in large cylinder castings.

Blading Material.—Stainless iron or steel is now largely adopted for blading materials, and the author's firm have had excellent results from stainless iron for blading with Monel metal shrouds and either Monel or manganese copper dummy strip. The final selection of blading material, however, must depend on the steaming conditions, and no hard-and-fast rules can be laid down.

Exhaust end spindle blades which are relatively highly stressed are almost universally made integral with the root and spacing section. They may be machined from the solid bar, drop forged and then machined, or rolled from a billet, as done by the author's firm in recent years. Fig. 11 shows a typical Parsons integral blade and root, a type which has been so successful that not a single failure has been recorded since its adoption.

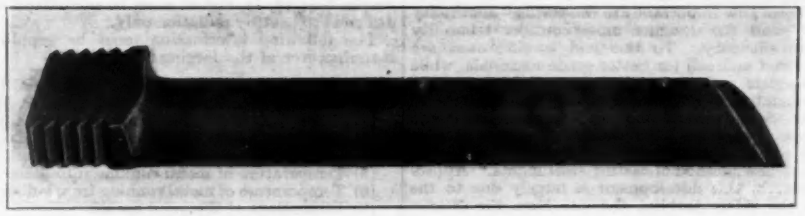


FIG. 11—INTEGRAL TYPE OF PARSONS' BLADING

Reliability and Operation.

Remarkable progress in the reliability of turbine plant has been made in the period under review, and this is particularly noticeable in the case of English manufacturers. The tendency both in America and on the Continent has been to increase initial pressures and temperatures rather more rapidly than in this country, and, considering how unknown is the field which has been explored, the difficulties encountered have been unexpectedly few. Increasing the output per exhaust with a consequent increase of blade tip speed has, however, produced unforeseen vibration troubles in certain instances, and the engineers of several plants of large output in the U.S.A. have been forced temporarily to remove the final row of blades until a satisfactory solution is obtained. Progress is made by surmounting the difficulties encountered, but recent experiences seem to justify the rather more conservative policy adopted by English designers.

A considerable amount of elaborate research work has been carried out on the subject of disc vibration, but isolated cases of this difficulty are still found and frequently prove costly to remedy. The phenomenon of disc vibration is one of which the author has fortunately never had personal experience, since Parsons reaction turbines have extremely rigid discs which butt against each other axially, so that disc vibration is impossible.

Blade Failures.—The associated problem of blade vibration, however, is one common to all types of turbine, and wise designers always determine the natural frequency of vibration of the blading to be used. An individual blade or group of blading may be set into synchronous vibration by the rotational frequency or in certain cases by the steam velocity, and the result may be rapid failure by fatigue. Such failures are nowadays extremely rare, and to indicate the improved reliability due to careful designing effected by the company with which the author is associated, Fig. 12 has been prepared, which shows the total number of kilowatts of plant put into service for the period under review, and the corresponding number of kilowatts of the plant out of service—no matter what the length of time—due to blading failures. The percentage of blade failures is also plotted. In explanation of this chart it should be added that every instance of blading failure has been included, even cases where slight damage has been done to the blading due to foreign matter or to causes quite external to the blading itself. For instance, in 1929, it will be seen that 40,000 kW of blading failures are logged, and this comprised a 25,000-kW plant in which the Michell thrust bearing failed due to faulty lubrication with consequent damage to certain rows of blading, and a 15,000-kW plant where one row of blading was damaged, the cause not having been satisfactorily determined. The machine in this case was out of service for thirty hours only. It will be seen that out of a total amount of plant ten years old or less, in service, the total failures during 1929 amount to less than 1 per cent., comprised of the two machines just mentioned.

During 1930 the only failure was on a 4000-kW machine, and was definitely traced to persistent boiler priming, while in 1928 not a single blading failure of any kind occurred.

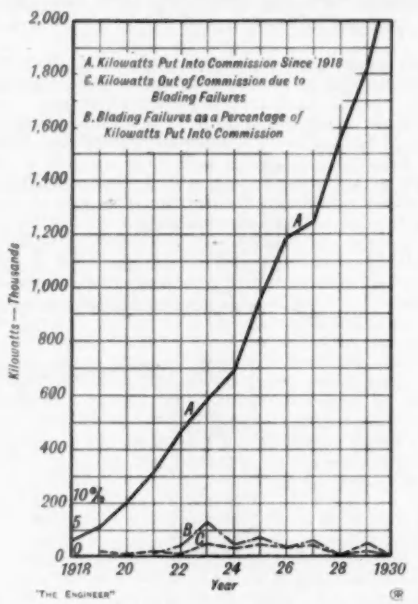


FIG. 12—KILOWATTS IN AND OUT OF SERVICE

Some Causes of Vibration.—With increase of turbine output it was, of course, necessary to use larger diameter steam pipes, and due to increased steam pressure, pipes of greater thickness were necessary. In consequence the stiffness or rigidity of the steam pipe as a whole became rather serious. Several instances of very severe vibration being set up due to steam pipe expansion troubles have occurred, and in more than one case the steam range had to be redesigned with special provision for dealing with expansion. Some manufacturers calculate the expansion which may be expected, and allow for this when making the closing lengths so that the expansion forces are minimised when the machine is running and the steam pipe is at high temperature.

It is suggested that a much better way is to complete the steam range to the stop valve, providing distance pieces—say, 2in. thick—in the three planes which need adjustment. The stop valve is then removed from the turbine and a blank flange fitted to the end of the steam pipe with a large-bore drain blowing to atmosphere. Trammels are made with the steam pipe cold, and steam is then turned on to the range and the drain at the end of the pipe allowed to blow until the temperature of the pipe rises to its full extent. The amount of movement from the cold to the hot condition is then measured by the trammels, and the distance pieces in the steam range are adjusted to ensure that no forces are applied to the steam chest when the steam range is at full temperature. With very large machines, designed for high pressures, however, occasional instances of vibration have been reported, and where a steam chest is employed it is excellent practice to anchor it securely and to provide flexible U-pipes between the steam chest and turbine cylinder. The steam chest is set in position so that forces from the pipe between steam chest and cylinder cannot affect the turbine cylinder. The main steam range is tested for expansion as described above, although, of course, in the case where the steam chest is securely anchored, elimination of steam pipe forces is not so vital.

An interesting cause of vibration which was found on some of the first machines to employ total steam temperatures in excess of 700 deg. Fah. was the lifting of "dummy strip" which had been put in in lengths of 4in. to 5in. Due to the small section of the dummy strip and the fact that at that time it was made of 70/30 brass, the dummy

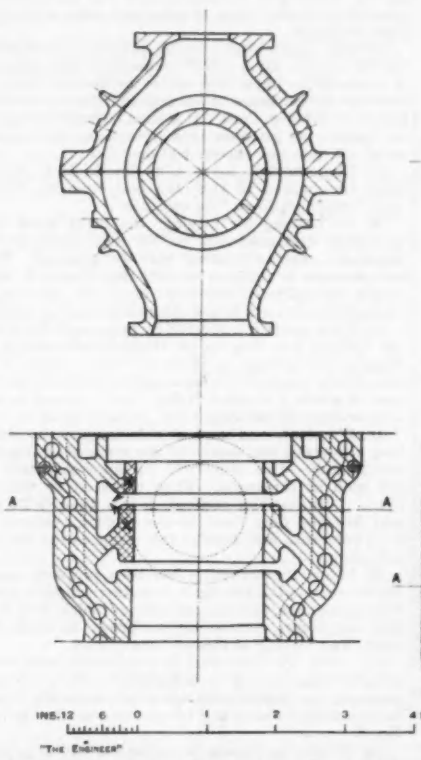


FIG. 13—CYLINDER LIABLE TO DISTORTION

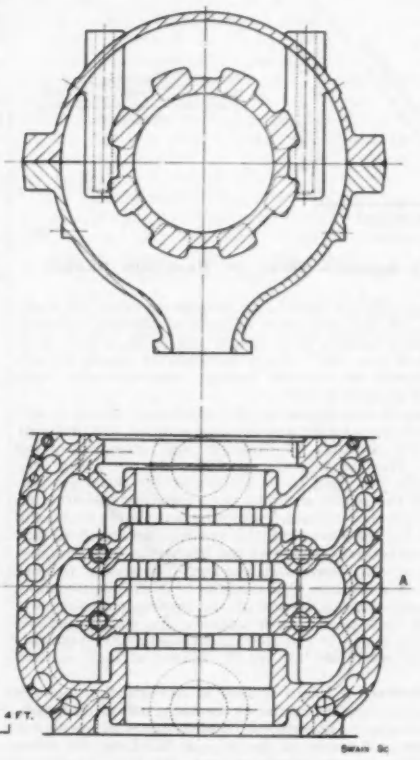


FIG. 14—MODERN CYLINDER

strip reached steam temperature very much more rapidly than the steel casting into which it was fixed, and owing to the differences in expansion coefficients the strip was subjected to considerable stress while it was at steam temperature. The rapid increase in length of the dummy strip during starting periods caused it to lift out of the groove and to come in contact with the shaft thus causing vibration, whilst in addition to 70/30 brass rapidly disintegrated and became very friable, due, it is thought, to being heated whilst under stress. The complete cure of this trouble was obtained by inserting the dummy strips in lengths not greater than 1in. and by making no attempt to butt the pieces accurately against each other, so that they were able to expand into the small gaps left between them and thus did not rise nor were they stressed to an extent which produced disintegration. With the advent of still higher temperatures, however, it has been found advisable to use a more suitable material; manganese-copper is satisfactory up to, say, 725 deg. Fah., and a cupro-nickel alloy of the Monel or similar class for a temperature of 800 deg. Fah.

Vibration has occasionally been traced to cylinder distortion, and to illustrate this problem Fig. 13 shows an earlier design of reaction turbine cylinder, which occasionally distorted sufficiently to bring dummy strip into contact with the shaft. The area shown shaded will be approximately at full steam temperature, whilst the outer wall, despite efficient insulation, will be at an appreciably lower temperature, especially at the horizontal joint flanges. The shaded area tends to expand radially outwards, but is prevented from doing so by the outer wall, and as a result the points x tend to move in the direction of the arrow-heads. This distortion may be assisted by incomplete annealing.

A complete cure of cylinder distortion has been found by redesigning the cylinder so that the inner walls have a greater rigidity than the outer shell. This is accomplished by casting heavy ribs connecting the high-pressure "dummy" cylinder with the cylinder proper and casting links between all belts along the length of the cylinder, as shown in Fig. 14. The engraving is a plan view looking on the horizontal joint and the interconnecting ribs are clearly seen. It will also be noticed that to give greater flexibility to the horizontal joint flange, slots are cut from the horizontal joint bolts to the outside of the flange. Note also that long studs from the bottom half of the cylinder at its inner bore are carried right through the cylinder cover, thus enabling that portion of the joint to be made steam-tight and adding appreciably to the rigidity of the inner bore.

Increase in the size of turbines has also introduced a difficulty occasionally experienced when the machine is to be started some hours after it has ceased to carry load and before it is cool. This is due to the heat from the high-temperature end travelling down the spindle in such a manner that the temperature at any one radial plane is not uniform, with the result that a temperature deflection is produced in the spindle. It is probable that this deflection is upwards, due to the spindle being hotter at the top of the cylinder than at the bottom. Vibration due to this cause may be eliminated by turning the shaft through 180 deg. at regular intervals, say, every hour, thus preventing the distortion; or its effect may be reduced by starting the turbine on a very low vacuum, thus passing a larger quantity of steam at a much greater density along the back end. Most very large machines to-day are fitted with some form of turning gear, which is either of the intermittent or of the continuous turning type.

The provision of a turning gear is one which requires considerable thought, since, if it is of the continuous type, it will be necessary to maintain a minimum surface speed on the journal in order to maintain a film of oil and thus to keep the coefficient of friction within limits. For a 15in. diameter journal the minimum speed is about 20 r.p.m., and a turning gear which is robust enough to start the turbine from rest will probably be from five to eight times too large once this minimum speed is reached and an efficient film of oil secured in the bearings. For a turning gear of the intermittent type a coefficient of friction of about 0·03 must be reckoned with when turning at a low speed. A 50,000 kW, 1500 r.p.m. turbo-alternator will probably require a torque equivalent to about 300 H.P. applied to the turning gear to start it from rest. This power can be very considerably reduced by providing a system of high-pressure lubrication to the centre of the bottom half-bearing of sufficient pressure to lift the journal clear of the bearing and provide a film of oil. The necessary pressure of oil varies, of course, with each machine, but is generally between 600 lb. and 1000 lb. per square inch. Should provision for high-pressure oil be made, the coefficient of friction will be reduced to, say, 0·0035, and the power required for the intermittent turning of a 50,000 kW set reduced to about 40 H.P.

Internal Forging Stress.—A rare, but very interesting cause of vibration in a turbine shaft came to the author's notice a few years ago. A small turbine of 1000 H.P. designed to run at 8000 r.p.m., was started on the test-bed coupled through reduction gearing to a Froude dynamometer. After running quite satisfactorily for 2 or 3 hours, a slight harsh vibration was observed which gradually got worse. The usual examination and easing of bearings, &c., was made, but after a few hours' running this vibration was again evident. The balance of the spindle was checked in a dynamic balancing machine and found correct, and it was, therefore, decided to run the turbine spindle up to full speed in its own bearings, and the bottom half of the cylinder by driving it through gearing from a motor. The balance at 8000 r.p.m. was quite satisfactory, and prolonged running did not produce any vibration. The turbine was of the impulse type, the discs having been machined from the solid, so that they were integral with the shaft. A theory was put forward that the vibration was caused by the release of internal forging stresses at working temperature, despite the fact that the steam temperature under which the machine operated was quite moderate, and to test this the shaft was slowly rotated in a gas-fired furnace, taking some 14 to 15 hours to raise it to a temperature of 1000 deg. Fah. Attempts were made to determine whether the shaft deflected while being heated, but the results were not conclusive or very reliable. The shaft was allowed to cool very slowly, and it was then put into the lathe and skimmed all over the body, the maximum departure from accuracy being 0·002in. before skimming.

No further treatment or modification was given to the shaft, and as it has now been in daily commercial service for over four years it can be assumed that the vibration trouble was due to internal stresses in the spindle forging.

Shortly after this interesting, but worrying, experience, a very large single-cylinder turbine which had been in service for some three years, running under a steam temperature of 600 deg. Fah., was changed over to a steam supply at a maximum temperature of 750 deg. Fah. from a new boiler. Within a few weeks, vibration commenced, and it was found that the spindle was bent at a point in the shaft where the diameter of the forging was 32in. The shaft was straightened, but two months later it again bent, and it was then decided to straighten the shaft, "roast" it to a temperature of 1000 deg. Fah. whilst slowly rotating, and then to skim the body of the shaft true. This was done and the turbine has continued in service since that time with the greatest satisfaction.

These two examples, despite their rarity, are considered to be sufficient justification for rigid insistence upon the specification for forging manufacture, which is laid down in this paper and which states that from the pouring of the ingot to the final annealing of the forging, the forging must not be allowed to cool below 600 deg. Cent.

Bearings.—A natural consequence of the increase in turbine output has been an increase in bearing journal loading and surface speed. Pressures per square inch of projected area up to 140 lb. have been successfully used with a surface speed of 175ft. per second. The bearing giving these maximum figures was not scraped in any special manner, but was bored according to the standard practice of the author's firm, which is identical with that described in the recent paper by Mr. Francis Hodgkinson.†

Bolting for High Pressures.

The increase of steam pressures has shown the advisability of using a method of tightening bolts which permits of some measure of control. The very crude "flogging" up of large bolts and nuts is frequently followed by undesirable consequences. The author's firm have developed a simple method of heating bolts electrically which has proved to be simple, speedy and very effective. Fig. 15 shows the method of applying the heating, while in the same figure are shown two methods of connecting the carbons, depending whether the available supply is an earthed system or otherwise.

The power input is from 4 to 5 kW per bolt, two bolts being heated at a time, and either an A.C. or D.C. supply varying from 100 to 250 volts being used. The design office determine the amount of tightening which is to be done, and after screwing the nut on to the flange and making it hand-tight when using an ordinary spanner, the current is switched on and the bolt heated. Still using hand pressure only on the spanner, the nut is rotated through an arc previously determined by the design staff. As soon as the tightening is sufficient the current is switched off, and a 3¼in. diameter bolt can usually be tightened in approximately 15 minutes.

This method has been found very useful in reducing the seizing between nuts and bolts which is found when opening up machines which have run under a high degree of superheat for long periods, since the pressure on the threads is entirely removed before any attempt is made to rotate the nut.

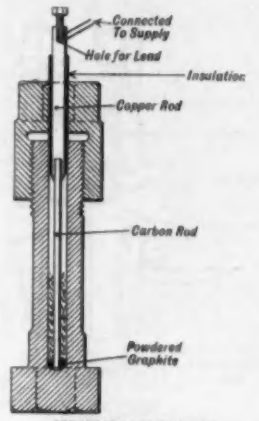


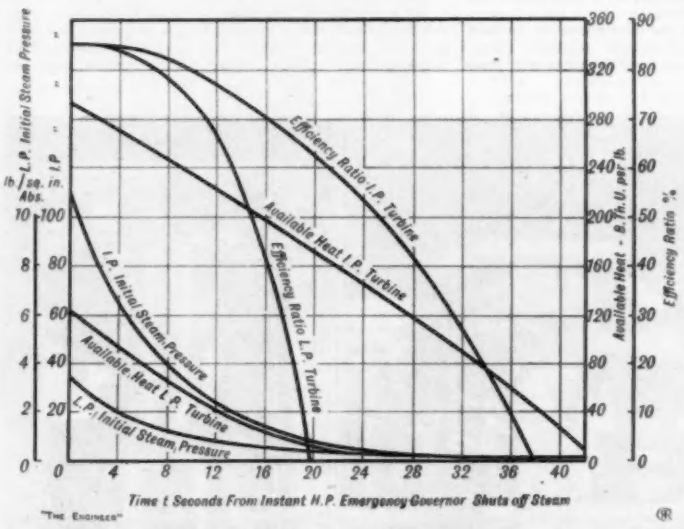
FIG. 15—ELECTRICAL METHOD OF TIGHTENING BOLTS

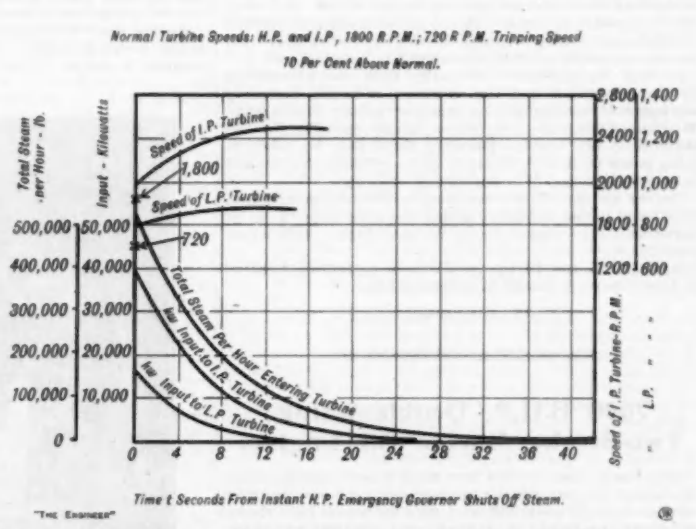
Possible Speed Rise of Reheat Turbines.

The limitation of total steam temperature to something like 850 deg. Fah. makes reheating or resuperheating an absolute necessity if full advantage is to be taken of the increased pressures which are certain to be used in the future. This introduces a problem which is of considerable importance in the design of turbine plant, namely, the calculation of the rise in speed of the lower-pressure spindles due to the steam stored in the turbine, reheater, and interconnecting pipes. It is assumed that the load goes off the alternators, that the high-pressure emergency governor operates, but not the reheat pressure emergency valves, and, thirdly, that the vacuum breaker fails to act, so that full vacuum is maintained on the system. A combination of circumstances such as this may not appear at first sight to be a likely one, but it should, nevertheless, be considered, and the turbine design arranged accordingly. The matter is of greatest importance when the reheating is carried out by boiler flue gases, as distinct from steam reheating, for this involves the use of long pipes of large capacity running to and from the boiler-room.

The problem considered below is to ascertain what will be the maximum rise in speed, and how long it will take to reach it under the circumstances outlined above, so

† "Proceedings," I. Mech. E., 1929, vol. ii.


I.P. Initial Steam Pressure lb./sq. in. Abs.
Efficiency Ratio I.P. Turbine
Available Heat I.P. Turbine
I.P. Initial Steam Pressure
Efficiency Ratio L.P. Turbine
Available Heat L.P. Turbine
L.P. Initial Steam Pressure
Available Heat - B.Th.U. per lb.
Efficiency Ratio %
Time t Seconds From Instant H.P. Emergency Governor Shuts off Steam
"The Engineer"


Normal Turbine Speeds: H.P. and I.P., 1800 R.P.M.; 720 R.P.M. Tripping Speed
10 Per Cent Above Normal.
Total Steam per Hour - lb.
Input - Kilowatts
Speed of I.P. Turbine
1,800
Speed of L.P. Turbine
720
Total Steam Per Hour Entering Turbine
kw Input to I.P. Turbine
kw Input to L.P. Turbine
Speed of I.P. Turbine - R.P.M.
L.P.
Time t Seconds From Instant H.P. Emergency Governor Shuts Off Steam.
"The Engineer"

FIGS. 16 AND 17—*Curves showing calculated Effect of Discharge of Reheater and Pipes into H.P. and L.P. Turbines after H.P. emergency governor has shut off steam from boiler—Large three-cylinder reaction turbine with reheater.*

that the safety of the plant in the event of a possible accident may be judged. The case taken is that of a three-cylinder machine in which the reheating is carried out between the high-pressure cylinder exhaust and the intermediate-pressure cylinder inlet. In this case the volume of the steam is that in the high-pressure cylinder, in the pipe line from the high-pressure exhaust to the reheater, in the reheater itself, in the return pipe line to the intermediate-pressure cylinder, in the intermediate-pressure cylinder, in the pipes from the intermediate-pressure to the low-pressure cylinder, and a portion of the steam in the low-pressure cylinder. If there are feed-water heaters supplied with heating steam from the intermediate-pressure and low-pressure turbines, these will form additional means of absorbing the steam remaining in the system, and the acceleration of the turbine will be correspondingly reduced. In the following outline of the method of calculation, it will be assumed that there is no steam extraction.

When a rotor, running at any given speed N, has the motive power P suddenly cut off and is allowed to slow down under the influence of energy dissipation, the rate of change of the kinetic energy of the rotor at any instant must be equal to the losses, *i.e.*

$$-\frac{d}{dt}\cdot\left(\tfrac{1}{2}\,I\,\omega^2\right)=L \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

In the inverse case of a rotor being suddenly accelerated "light" by the application of motive power P, we have

$$\frac{d}{dt}\cdot\left(\tfrac{1}{2}\,I\,\omega^2\right)=P-L \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Equation (2) represents the state of affairs in a multi-cylinder turbine with reheater and pipes of large capacity, when the generator load suddenly vanishes.

It can be shown that during the time interval t during which the stored steam is discharging into the intermediate-pressure and low-pressure turbines, the initial steam pressure p in the reheater decreases in a manner given by the equation

$$p=a\,\cosh\left(\frac{b}{c}\cdot\frac{A-t}{V\sqrt{\Sigma}}\right) \quad . \quad . \quad . \quad . \quad (6)$$

while the rate of the steam discharge through the blading is determined by the equation

$$-\frac{dQ}{dt}=\frac{a}{c\sqrt{\Sigma}}\cdot\sinh\left(\frac{b}{c}\cdot\frac{A-t}{V\sqrt{\Sigma}}\right) \quad . \quad . \quad (7)$$

a being the back pressure in the condensers, V the volume of the reheater and pipes, and b, A, Σ constants for a given case. From this knowledge of p and $\frac{dQ}{dt}$ at any instant, the power input P into the turbines can be assessed thus

$$P=\left(\frac{dQ/dt\times h_a\times\eta}{3412}\right)\text{kW} \quad . \quad . \quad . \quad . \quad (8)$$

h_a being the available heat read off the Mollier chart and η being the blading efficiency, calculated from the velocity ratio.

The progressive rise in speed of the turbine rotors may now be calculated, the initial kinetic energy being assumed to be that contained at the runaway speed, *i.e.*, at the moment when the high-pressure emergency valve closes.

Neglecting for the moment the retarding effect of the losses, and writing E for the energy input from the steam at any instant dt, so that $E=P\,dt$, we have

$$\tfrac{1}{2}\,I\,\omega^2=\left(\tfrac{1}{2}\,I\,\omega_1{}^2+E\right)$$

so that

$$\omega^2=\frac{\tfrac{1}{2}\,I\,\omega_1{}^2+E}{\tfrac{1}{2}\,I}=\omega_1{}^2+\frac{2\,E}{I}$$

and therefore

$$N=\frac{30}{\pi}\sqrt{\omega_1{}^2+\frac{2\,E}{I}} \quad . \quad . \quad . \quad . \quad (9)$$

from which the curve of N on a basis of t can be plotted.

In order to take into account the losses, it should be noted that these depend upon the speed N, and that they are comparatively small. Hence in calculating the losses, it will be sufficiently accurate to take the values of N from the curve already plotted, assuming the losses absent.

It may be assumed arbitrarily that the alternators remain excited or not, and a curve of losses, including windage and bearing friction at any speed of rotation, may be obtained from the designers of the alternators. For the losses W in the turbine bearings, these may be taken as being equal to $K\,V^{1.5}$, where K is a coefficient determined by experiment and V is the surface velocity.

Curves for these losses can then be plotted on a base of time t and added together, giving the total losses L to be introduced into equation (9) in accordance with equation (2).

In Figs. 16 and 17 the results of a typical calculation on these lines are shown in graphical form.

(To be continued.)

7600 B.H.P. Double-Acting Two-Stroke Marine Oil Engine.

The bench trials of the first large Sulzer double-acting oil engine, constructed for marine service, were recently carried out at Winterthur, and were witnessed by a representative company of British and foreign engineers. The engine, which we illustrate on page 485, is an eight-cylinder unit, with an output of 7600 B.H.P. at 106 revolutions per minute. Each cylinder has a bore of 700 mm. (27½in.), and a stroke of 1200 mm. (3ft. 11½in.). The engine is to be installed in the single-screw motor ship "Tajandoen," belonging to the Stoomvaart Maatschappij "Nederland," which ship is one of the latest additions to a large fleet of passenger and cargo ships, of which sixteen are propelled by Sulzer engines of the single-acting two-stroke type. Nine of the later vessels of the "Poelau" and "T" classes are propelled by 7000 B.H.P. engines, some of which were built in Winterthur and others by Dutch licencees. The machinery of the "Tajandoen" will therefore give her owners an opportunity of comparing under service conditions the performance of a double-acting two-stroke engine with that of a single-acting engine of about equal output, while the operating staff will become familiar with a type which is capable of giving increased outputs and is likely to figure largely in future development plans.

This new Sulzer engine embodies in its design and construction the experience which has been gained by its builders during more than twenty years spent in the manufacture of single-acting two-stroke engines. In 1918 Sulzer Brothers had already constructed double-acting gas engines with outputs up to 1800 B.H.P. per cylinder,

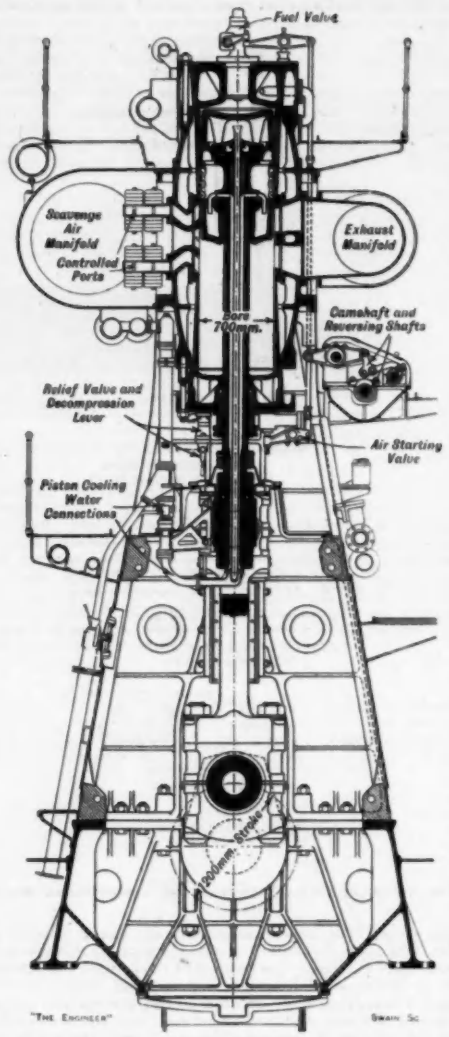


FIG. 1—SECTION THROUGH CYLINDER

which, we learn, are still in continuous service, while during recent years additional trials and experiments have been carried out on double-acting oil engines of medium and large cylinder output at Winterthur, and valuable experience thereby gained.

As our illustrations indicate, the bed-plate of the new engine follows closely the most recent practice, incorporating a deeply ribbed structure with transverse cross beams. Each of the bearing caps is secured by four bolts, which are deeply let into the bed-plate. These bolts are indicated in the lower part of Fig. 1, which also shows the arrangement of ribs in the bed-plate and the crank case casting. The main framing of the engine is of cast iron, and it is secured to the bed-plate by a series of closely spaced bolts. The crank case castings carry the service platforms. Large crank case inspection doors are provided, and in Fig. 3 we show one of these doors removed, giving access to the piston cooling pipes. The cylinder jacket castings have ends of a circular and symmetrical form, and are firmly bolted together and connected to the frame by a double row of bolts. The structure thus formed is designed not only to withstand the combustion and internal forces, but also to resist all external forces which are likely to be exerted upon it by movements of the ship. Under test conditions the engine was noticeably free from vibration. The arrangement of the scavenge air and exhaust ports on the port and starboard sides of the engine respectively is shown in Fig. 1. It will be seen that the centre portion of the cylinder jacket casting is of rectangular section, and the horizontal water-cooled partition which divides the upper and lower exhaust passages may be noted. The top and bottom ends of the cylinders are scavenged on the controlled port system, which has been so successfully employed in the single-acting type of engine. By using three rows of scavenge ports a very high scavenge efficiency, with a low scavenge air pressure, has been obtained. No difficulty has been experienced in scavenging the bottom side of the piston, and a smooth flow of air past the piston-rod has been attained. In the common uncontrolled port at the centre the scavenge air is led and deflected alternately to the upper and lower ends of the cylinder, while the upper and lower rows of ports admit scavenging and charging air through automatic valves of the plate type to the top and bottom ends of the cylinders respectively. As the combustion spaces are interconnected with the scavenge air receiver through the upper and lower charging ports after the exhaust ports have been closed, it is impossible for any fluctuation in the exhaust manifold pressures to effect the efficiency of air charging. The scavenge air is supplied by two direct-driven pumps, which are arranged in tandem and are mounted at the air compressor end of the engine. The main engine controls are also grouped at this end of the engine, and the fuel pumps are fitted at the side of the engine and are driven from the air compressor crossheads, a separate plunger being provided for each cylinder. The crosshead is generally similar to that employed in the single-acting engine and water-cooled guides are used which are attached to the columns. The lubrication is effected from the hollow connecting-rod, which is fed from the forced lubrication system. As the crosshead is symmetrically placed in the vertical longitudinal plane of the engine, equal ahead and astern guide surfaces are given.

The piston-rod passes through the crosshead and is secured by nuts above and below it, this arrangement permitting an adjustment of the compression spaces. The cooling water enters the rod below the crosshead, and passes up through the centre bore, returning by a pipe fitted within that bore. As the piston-rod gland is deeply sunk into the lower cover, it is well cooled, and the design is such that it can be lowered in a downward direction, free space for such withdrawal being provided between the crank case top and the lower cylinder cover face. The general accessibility of this part of the engine is illustrated by the views reproduced in Fig. 2.

The piston itself calls for little comment, and it follows closely standard design. Fresh water cooling is fitted throughout, although if desired sea water could be utilised for cylinder cover cooling. The piston cooling gear is clearly shown in our illustrations Figs. 1 and 3, and it is easily accessible outside the crank case, the cooling water jet being observed through inspection doors specially provided for this purpose and indicated to the right of Fig. 2. The cylinder liner is of the two-piece type, each half carrying one row of charging ports and one half of the common row of scavenging ports. Sufficient play is left at the centre for expansion, and alignment is maintained by a groove and tongued joint between the two liner halves, which is so designed that the piston rings pass over the joint without any jar. The halves are inserted from the top and bottom of the cylinder jacket respectively.

On a level with the lower cylinder cover—see Fig. 1—the cam shaft and reversing shafts are arranged, and the gear follows very closely that normally employed in the single-acting type of engine. This remark also applies to the top cylinder cover, which has a centrally placed fuel valve of enclosed design. In the case of the lower cylinder cover, however, there are four openings, in addition to the piston-rod stuffing-box gland. On the centre plane of the engine there are the two fuel valves—see Fig. 2—and, as shown in Fig. 1, an air starting valve and a relief valve with a lever-operated decompression device for starting. The fuel valve drive has in all cases

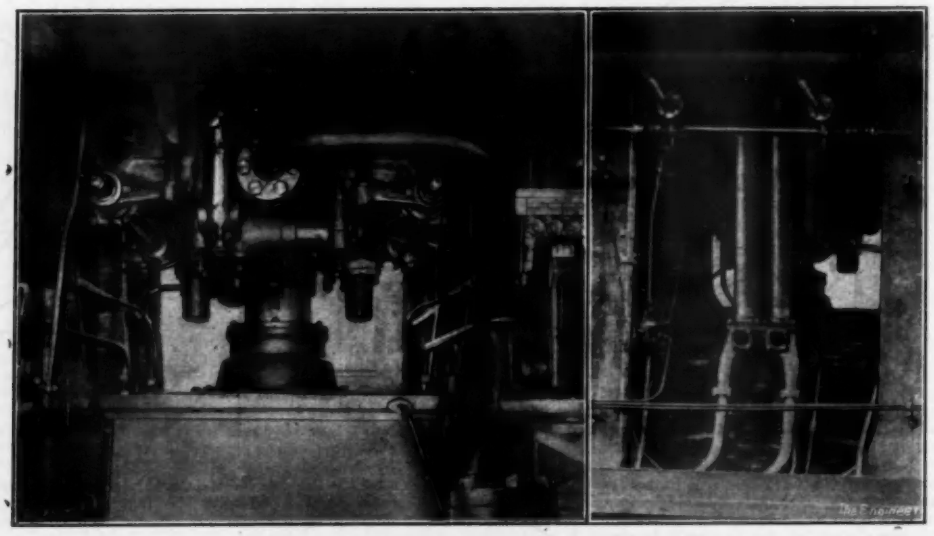


FIG. 2—BOTTOM END OF CYLINDERS SHOWING VALVES AND PISTON COOLING PIPES

7600 B.H.P. DOUBLE-ACTING TWO-STROKE MARINE OIL ENGINE

SULZER BROS., WINTERTHUR, ENGINEERS

been so planned that all the valves can be quickly dismantled without having to remove the driving levers. The lower cover, like the top cover, is held in position by a special press ring, the object of which is to prevent possible distortion which might be caused by the ordinary fixing bolts.

In order to manœuvre the engine, starting air is admitted to the lower ends of the cylinder only, the top ends remaining on fuel. Since the top ends of the cylinders are not cooled by the starting air, the engine starts very easily, and as soon as the top ends begin to fire the starting air is cut off and fuel is also admitted to the lower ends of the cylinders. All the starting and reversing mechanism is automatically operated by two servo-motors, one being fitted for the starting and the other for the reversing operations. The main control station is at the end of the engine, the manœuvring platform arrangements and the details

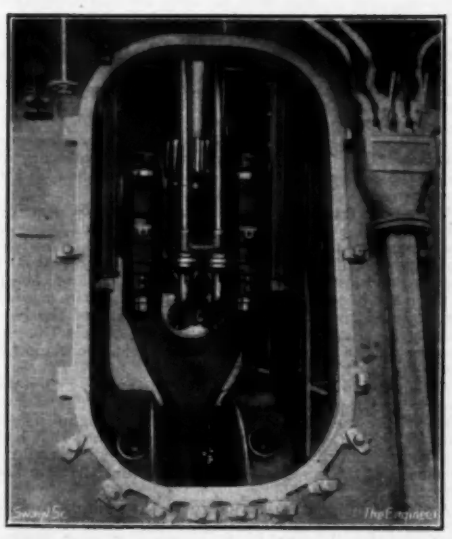


FIG. 3—CROSSHEAD WITH PISTON COOLING PIPES

of the control mechanism being of the usual Sulzer type. In order to provide current for auxiliary purposes in the ship, three generator sets are to be installed, two of which will be driven by a 400 B.H.P. six-cylinder engine and one by a 200 B.H.P. three-cylinder engine. These engines, which are of a new design, operate on the four-stroke, single-acting principle, and run at a normal speed of 300 r.p.m., employing airless injection.

The bench trials of the new double-acting two-stroke engine which we have described only included a very short fuel consumption test, as the full official trials of the engine have still to be carried out. The test was, however, sufficient to show that the fuel consumption obtained was fully as good as that of the single-acting two-stroke engine, and the makers are of opinion that in actual practice a consumption even lower than that of the normal single-acting two-stroke will be reached. Throughout the tests the engine ran very smoothly, and in the opinion of those who were present it marks an important forward step in marine engine design.

Main Line Electrification.*

IN September, 1929, the Minister of Transport appointed a Committee, consisting of Lord Weir, who was Chairman of the 1926 Committee on the National Electricity Supply; Sir Ralph Wedgwood, chief general manager of the London and North-Eastern Railway; and Sir William McLintock, the well-known chartered accountant, to examine the economic and other aspects of the electrification of the railway systems of Great Britain, with particular reference to main line working, and to report their conclusions.

The Committee have now submitted their report, the preparation of which has taken a longer period than was anticipated, owing largely to the necessity for certain detailed investigations referred to below; they have considered, not only the direct results as affecting the railways, but also the reactions on the national electricity supply and the effect on industry generally, and their conclusions are summarised in Part III. thereof. The reference did not instruct the Committee to make recommendations, and, as they point out in their concluding paragraph, any programme of general electrification involves national, financial, and possibly ultimate political considerations and implications which they do not feel it is any part of their present duty to discuss. The object of the Committee has been to make clear the essential economic factors involved, and they present the results of a dispassionate investigation into this portion of the problem.

After a general review of existing electrifications, the Committee satisfied themselves that main line electrification has proved satisfactory and is making steady progress in many countries, but that the principal reasons which have led to such schemes do not, generally speaking, apply in Great Britain; on the other hand, the scarcity of water power in Great Britain is not a handicap. Further, the well-proven success of suburban electrification in Great Britain and elsewhere is no conclusive guide to the probable results of main line schemes, although it does present *prima facie* considerations in their favour.

The Committee then decided that conclusive data for British main line conditions could only be obtained by a detailed expert examination of typical sections of actual British systems. Arrangements were made accordingly with Messrs. Merz and McLellan to carry out, in co-operation with the railways concerned, investigations into two sections: (*a*) the King's Cross-Doncaster-Leeds line of the London and North-Eastern Railway, together with its branches, covering roughly the whole of the old Great Northern system; and (*b*) the London, Midland and Scottish Railway line from Crewe to Carlisle, including the line from Crewe to Liverpool, and a few small branches.

The results of these investigations—given in full in appendices to the report—and the deductions therefrom are of great value. The scheme for the selected section of the London and North-Eastern Railway showed an estimated return of over 7 per cent., while on the particular section of the London, Midland and Scottish the return was estimated at 2½ per cent. only. The main explanation of the difference is to be found in the limited extent of the latter scheme and the handicap of maintaining dual working of steam and electric trains in the same area, so long as this section of the line only is electrified.

After consideration of these reports and of the evidence of a number of experts on railway operation and electrification, including a very comprehensive review of the whole question by Mr. J. M. Kennedy, of Messrs. Kennedy and Donkin, the Committee were convinced that in order to secure the fullest economic benefit from railway electrification any scheme adopted should be a comprehensive one covering the whole railway system of the country, with the exception of those branch and other lines on which the traffic is too light to justify the capital charges of electrification, and where conditions are such that the handicap of dual working would not be serious.

They therefore prepared estimates of capital and operating costs largely based on the data furnished by these detailed investigations, and conclude that, assuming such a scheme were carried out over a period of about twenty years, the new capital expenditure involved on the part of the railways would be approximately £261 millions, and estimating on a conservative basis and on the maintenance of the present volume of traffic, the return obtainable through various economies in expenditure as compared with the cost of steam working would represent about 7 per cent.

The Committee remark that this return would leave a surplus of approximately 2 per cent. after meeting interest charges on the new capital involved, and while in their view this would in itself be too narrow a margin for the risks and contingencies involved, they point out that it takes account only of direct economies and ignores a number of substantial advantages, including speed, comfort, amenity and improved service, the value of which cannot be expressed in terms of cash. It is pointed out that "Electrification places in the hands of the Traffic Manager a new machine or system which enables him to offer a more attractive transport proposition to his public and whole special characteristics are capable of extensive development." Moreover, the calculation is made on existing traffic, but improved service and general development should lead to increase of traffic and the possible financial benefits thereof are likely to be substantial. In Appendix II. the Committee explain in detail the reason why any increase of traffic tends to be in favour of electrical operation. In one direction the Committee have attempted (Appendix III.) an assessment of the financial effect of increased traffic where there is good reason to anticipate such increase, viz., on a broad estimate they anticipate that schemes for intensifying suburban working after electrification would yield a return of about 13 per cent. on an additional capital expenditure of about £45 millions.

It should be noted also that the figure of £261 millions is based on the electrification of the whole steam-operated mileage of the country, 51,500 track miles of running track and sidings, and would be reduced by the elimination of the lightly loaded branch and other lines, &c., which would not in practice be electrified; further, that any increase or decrease in the price of coal would increase or decrease the relative advantage of electrification.

Apart from the advantages to rail transport, a factor of great importance is the effect of the increased load—about 6000 million units of electricity per annum—with its high load factor, on the national electricity supply system, and the consequent favourable reaction on the cost of electrical energy produced for all purposes; the additional network of transmission lines required should also do much to accelerate rural electrification.

The Committee discussed alternative systems of haulage and the possibility of technical developments, such as oil-electric traction, but see no reason to anticipate obsolescence of electrical equipment, or any circumstances which are likely to displace the railways from their position as the main transport agency of the nation.

In addition to the expenditure on the railway companies' system, there would be a further expenditure by the Central Electricity Board or electricity supply undertakers, amounting to about £80 millions, in excess of their existing programmes, on which the Board and the undertakers are assumed to earn their normal revenue in the shape of payment by the railway companies for current supplied.

The total capital expenditure involved in the scheme

* Official abstract of Report of the Committee on Main Line Electrification, 1931. Published by H.M. Stationery Office. Price 3s. net.

would thus be in the neighbourhood of £340 millions, apart from a further possible expenditure of £45 millions in intensifying suburban services. As the Committee point out, the magnitude of such an operation would be unique in the history of world enterprise, and the figures alone suffice to show the need for careful study of all the material and implications contained in the report.

Summary and Conclusions.

We are not asked in our terms of reference to embody in our report any definite recommendations, but, as a final result of the foregoing, we have come to certain unanimous conclusions of major importance which we now summarise.

(i) The existence of the national scheme of generation of electrical energy and the consequent low prices and availability of such energy constitute a new and favourable factor in the economics of further railway electrification in Great Britain.

(ii) An efficient and progressive railway system is and will continue to be a matter of vital importance to the nation.

(iii) In view of the competition of road transport and the existing industrial and agricultural depression, it is essential that the railways should examine new methods of reducing the costs of railway transportation.

(iv) Comprehensive electrification of main line railways has not taken place in any foreign country except Switzerland, but, generally speaking, railway electrification is making steady progress in many parts of the world.

(v) The main reasons which have led to the adoption of electric haulage in foreign countries, broadly speaking, do not apply in this country, and they have not offered any conclusive guide or assistance in our investigations.

(vi) British railway electrification up to now has been confined to suburban lines, and the results, economic and otherwise, have been favourable.

(vii) The economic success of British suburban electrification is due to the substantial increase in revenue following on the much improved service which an electrified railway can provide.

(viii) Suburban electrification provides no sound comparison of actual operating costs of steam and electric haulage, but it does present certain *prima facie* considerations in favour of electric haulage for main lines.

(ix) The increased load on the national system which electrification of the railways would contribute, together with its high load factor, would react most favourably on the cost of electrical energy produced for all purposes, while the additional transmission network required for railway electrification would do much to accelerate rural electrification throughout the country.

(x) In the event of a scheme of main line electrification being adopted, the Central Electricity Board should be given statutory power to supply electrical energy direct to the railways for electrification schemes. In addition to this railway companies should be entitled to utilise, for purely railway purposes, at any point in their systems, supplies of electrical energy obtained from the Board or any other authorised undertakers.

(xi) In any comprehensive scheme of railway electrification the Central Electricity Board should provide the transmission lines, build and equip the sub-stations, and supply the energy at the D.C. bus-bars of the sub-station, but the operation and control of the sub-stations should be in the hands of the railway companies.

(xii) In regard to the most suitable system of electrification, the report and recommendations of the Pringle Committee should be followed.

(xiii) Improvements in the fuel economy of steam tractors will take place, but such economy is likely to be counterbalanced by higher capital costs and maintenance charges.

(xiv) The most promising alternative to steam haulage, other than electrification, rests in the development of the oil engine with electrical transmission to the driving wheels, but experience of this system is still limited, and it would appear that on well-loaded lines this system must always be less economical than electrification.

(xv) In considering alternatives to the steam locomotive preference should be given to systems using coal rather than oil as being in the national interest.

(xvi) Apart from the direct financial economies of electrification as disclosed in comparative costs of operation, electrification offers important indirect advantages associated with speed, comfort, amenity, improved service, and increase of capacity.

(xvii) Leaving aside the financial aspects of the matter, the disadvantages of electrification relate almost entirely to the dependence of the system on centralised sources of electrical energy.

(xviii) The main items of haulage cost which can be materially reduced by electrification are locomotive wages and locomotive repairs.

(xix) Unless special conditions obtain, the electrification of small sections of a main line railway system is unlikely to be economically justified on account of the costs of dual working, and the consequent inability to take the fullest advantage of the new capital expended on fixed equipment or haulage units.

(xx) To secure the fullest economic advantage of railway electrification in this country any scheme adopted should be a comprehensive one, preferably comprising all the non-electrified lines, less such branch lines as detailed examination may show to be more economically operated by independent haulage units either steam or oil electric.

(xxi) Assuming that such a scheme is carried out on a comprehensive programme over a period of from fifteen to twenty years, on a conservative basis and on the assumption of existing traffic, the new capital involved on the part of the railways would be approximately £261,000,000, and the return on this through the various economies would represent about 7 per cent.

(xxii) Apart from the direct return due to these economies other substantial advantages could be realised, the most important being increased revenue from suburban and inter-suburban traffic. On a broad estimate we anticipate that schemes of intensifying suburban working would yield an additional revenue of £5,850,000, representing a return of 13 per cent. on the additional capital expenditure of £45,000,000 which would be involved.

(xxiii) The figure of estimated capital expenditure is likely to be reduced due to non-electrification of lightly loaded lines, redundant lines, and sidings, and reduction in capital cost of tractors, &c., due to large-scale production, and a continuous manufacturing programme. On the other hand, some allowance must be made for the electrification of private sidings and private branch railways worked over by the railway companies in the process of the transfer of traffic.

(xxiv) In addition to the expenditure under this programme, there would be a further expenditure by the Central Electricity Board and authorised undertakers of approximately £80,000,000 in excess of existing programmes, on which these bodies would earn their normal revenue.

(xxv) The change over from steam to electric traction will not materially affect the conditions of railway employees other than those in the locomotive grades. Even in the case of these grades we anticipate the adverse effect of the change will be a limited and temporary character owing to the duration of the programme, together with the probable increase in suburban and other train mileage. The matter, however, is one which should be more closely examined if it should be decided to proceed with the scheme.

(xxvi) Apart from considerations of finance and railway administration, a comprehensive programme such as we have indicated, if it is to be undertaken, should preferably be carried out as a united co-operative scheme by the railway companies, in order to obtain the best results from the technical, construction, and supply standpoint.

(xxvii) From the point of view of technical development and international competition the value of such a programme of domestic electrification would be most substantial to our national electric manufacturing industry.

General.—The preceding are the conclusions we have formed, and we would bring our report to an end with one general observation. The existing railway system is a vital part of the equipment of our country and its efficiency and economy affect the lives of practically every inhabitant, our industry, and our agriculture. A definite decision to alter the haulage system on a comprehensive programme, which, in our view, is the only method of achieving complete success, would involve a commitment of capital expenditure by the railways of about £261 millions, and of about £80 millions by the Central Electricity Board and other authorities, apart from the extra expenditure necessary in order to realise an intensive suburban development. The magnitude of this would be unique in the history of world enterprise.

On the other hand, we feel bound to point out that without any predetermined long-term programme, our national expenditure on the construction, improvement and maintenance of roads in the last ten years has probably amounted to the colossal sum of £500 millions and is now proceeding at the rate of over £60 millions per annum. Road haulage is in direct competition with the railways for a large amount of traffic, but, unlike the railway system, there exists for the roads no balance sheet or computation of profit and loss. There is no definite economic test of financial soundness. With this reflection in mind, we have no hesitation in concluding that the mere magnitude of the sum involved in complete electrification of our railways should be no deterrent in itself to the most careful and earnest consideration of such a programme on its economic and social merits. The decision involves national, financial and possibly ultimate political considerations and implications which we do not feel it is any part of our present duty to discuss, but we trust that towards the consideration of the problem which will no doubt take place in the minds of those concerned, the railways, the Government and the country, we have at least made clear the essential economic factors.

From no mere precedent or tradition do we pay our tribute to our Secretary, Colonel Trench, who has been indefatigable in the interests of thoroughness, invaluable as regards the technical aspect and happy in his unfailing courtesy, and to whom we extend our united thanks and appreciation.

A New View on Politics and Science.

A highly successful innovation was introduced at the annual dinner of the Chemical Engineering Group of the Society of Chemical Industry, which was held at the Waldorf Hotel, London, on April 24th. In view of the approaching jubilee celebrations of the Society of Chemical Industry, it was decided to make the annual dinner of more importance than the usual rather domestic gathering, and arrangements were made for an address by Sir Richard Gregory, which, whilst bearing the perhaps common-place title, "Science in Industry," followed a rather new line of thought, and, moreover, also produced a reply from a Labour politician, which also contained something of a new outlook in the attitude of politics towards science.

The central point of Sir Richard Gregory's address was that all the inventions upon which our large industries are based have been purely scientific laboratory experiments, which, at the time, were thought little, or nothing, of, from the practical point of view; that the scientist is not given the place by Government in national affairs that he should have; that he is inadequately remunerated for the immense services he renders to the welfare of a nation; that the almost sole attitude of Government towards the industrial results of scientific invention is to tax them, and that the time has come for a reconsideration of the whole position of science and industry in national politics. The whole of the Civil Service, said Sir Richard, was dominated by century-old traditions. The Civil Service was established when there was no scientific education of a systematic kind, and in those days the Civil Service was of the old traditional country-gentleman standard. Notwithstanding, however, that conditions had changed, the Civil Service remained the same. The scientific and technical man, when he was called in at all, was called in as a secondary person to give a sort of night-school talk to some statesman who was in authority, or some chief secretary who had no idea of what science really means. Modern technical achievement and scientific thought, however, foreshadowed a new economic structure for society in which those with scientific knowledge should exercise a decisive influence upon the major policies of the State as well as upon their administration. That position, however, would not be reached until scientific men played their part as citizens in seeing that they were adequately represented in Parliament. If there were, in the House of Commons, half a dozen men with scientific knowledge as well as the ability to place that knowledge before those who represented the community in Parliament, these people could rule the world. Unfortunately, there was not that number of scientific men in Parliament to whom they could go. Departments of public service would never achieve their maximum efficiency or be in a position to make their proper contribution to the solution of present-day industrial difficulties unless a greater effective share in administration was accorded to the scientific and technical expert.

In the earlier part of his address Sir Richard Gregory referred to many instances in which large industries have been based upon scientific laboratory work, and specially mentioned the experiments of Davy and Faraday. Commenting on the manner in which the manufacture of alloy steels has been rendered possible by the addition of elements which were formerly scarcely known by name outside chemical laboratories, he said that not a single chemical element had been discovered in an industrial laboratory or works and not a single one of them was thought to have any practical value when it was discovered. Sir Richard also claimed that the general effect of the application of science to industry had been to provide employment for more people than were formerly engaged in any particular industry.

Major A. G. Church, in proposing the toast of "The Society of Chemical Industry," dealt with some of the points mentioned by Sir Richard Gregory. In the first place, he alleged that the work of the scientist had resulted in the destruction of labour. In support of that he mentioned how the manufacture of synthetic indigo had deprived some 6 to 9 million people in India of their occupation in connection with the production of natural indigo. Similarly, the population of the islands of Pemba and Zanzibar, off the East Coast of Africa, had been deprived of their industry of cultivating the clove owing to the invention of synthetic methods. What was that but destroying labour? After defending the State against the charge of lack of interest in science, by pointing to the Government chemical laboratory at Teddington, the National Physical Laboratory, the Department of Scientific and Industrial Research and other Government Departments of a scientific nature, Major Church put the proposition that the difficulties in which the world is now finding itself are due mainly to the work of the scientist, and, therefore, it is the duty of the scientist to come to the help of the Government and assist it in finding solutions for the political chaos into which the world as a whole has entered. In doing so he asked the scientists to keep out of politics altogether, but to supply the politicians with real facts and not facts which had been cooked. The country had the right to expect, concluded Major Church, that the scientist would try and apply the same habits of thought and mind to the problems of the country as were applied in the laboratory to scientific problems. Politicians were not so contemptuous of science as scientists were of politics.

MARINE WEEK AT PETTERS, LTD., YEOVIL.

Last Saturday there was concluded at Yeovil the Marine Week of Petters, Ltd. Each year this firm devotes one week to providing extra facilities for visitors to view some part of the work that is being carried out in the shops. On this occasion marine engineers were invited in particular to observe the various types of oil engines which the firm manufactures.

Perhaps the most interesting of the machines to be seen running was the four-cylinder 160 B.H.P. reversible marine oil engine, which was exhibited at the British Industries Fair this year, and described in our issue of February 20th. Last week we had the opportunity of seeing the ease with which it could be controlled by the movement of a single wheel.

Many other engines, ranging from 400 B.H.P. down to 5 B.H.P. and less, were to be seen. Some of those of low power were so small that they looked very like models. Up to powers of 5 B.H.P. the machines run on petrol or paraffin, and are equipped with magneto ignition. Many of them are hopper cooled. Above 5 B.H.P. the engines are designed to run on crude oils, and are of the hot-bulb type. Engines, called by the firm Atomic Diesels, running on the compression ignition cycle, are made for powers of 25 B.H.P. and upwards.

Among many features of interest, the erecting shop for the smaller hot-bulb engines attracted notice. The various parts of the machines are erected as the engine passes slowly along a travelling band, and we saw one that had just been removed, completed, from the band started up by means of the combustible cartridge that the firm has patented.

An opportunity was also given to the visitors to pass through the aeroplane erecting shops. Here Westland machines of various kinds, descriptions of which will be found in numerous articles in the pages of previous issues of this paper, were to be seen. At present production is chiefly centred upon the "Wapiti" for the Royal Air Force, but, in addition, a "Wessex," a three-engined six-seater machine, was being erected, besides other types.

On the flying ground exhibition flights were made by a "Wapiti" and a "Widgeon," the latter being a two-seater monoplane, adapted for use in a club or as a private machine. Many of the visitors were taken for short flights. The Westland Hill Pterodactyl tailless pusher type monoplane aroused a good deal of interest, but on the occasion of our visit no flights were made with it.

Visitors were entertained to lunch and tea, at both of which meals interesting discussions took place. The week, so we were informed, had been very successful, although the weather for flying had not been absolutely ideal.

The London County Council proposes to expend £176,000 on the enlargement of the Lot's-road pumping station, and £156,500 on the Deptford station.

Railway and Road Matters.

No less than seventy-seven petitions have been presented against the London Transport Bill. No petition has been lodged in its favour.

THERE was issued on April 24th as a Stationery Office publication, price 3s., the report of the Committee appointed in September, 1929, to consider the problems involved in the electrification of the railway systems of Great Britain. The report is reviewed elsewhere in our present issue.

WE much regret to announce the death at Beaulieu-sur-Mer on April 20th of Mr. R. G. Berry, who was one of the most popular men in the railway signalling profession. He was the signal engineer of the Lancashire and Yorkshire Railway, and became the Manchester divisional signal engineer, London, Midland and Scottish. On the reorganistation of the signal and telegraph departments two years ago, Mr. Berry, whose health was not good, decided to retire. He was the President of the Institution of Railway Signal Engineers for 1929-30.

WITHIN the last few days, a new steamer, the "Cote D'Azur," built for the Société Anonyme de Gerance et d'Armament, has been put into service. She has been built at Granville by the Société Anonyme des Forges and Chantiers de la Méditerranée, and is 338ft. long, 43ft. broad, and has a draught of 12ft. She is oil-fired, and has two propellers, each driven by three geared turbines. The full power developed is 14,000 S.H.P., and her speed is about 23½ knots. Accommodation is provided for 900 first-class and 500 second-class passengers. When the second steamer is completed, it will be possible, by a rearrangement of the "Golden Arrow" service, to run every service with one of the latest and most modern steamers.

THE Ministry of Transport railway statistics for January have recently been issued as a Stationery Office publication, price 2s. 6d. They show that, compared with January, 1930, the number of passenger journeys decreased by 5·1 per cent. and the receipts therefrom by 6·8 per cent. Of the decrease of 5½ millions in the number of passengers, over 3½ millions were in those travelling at reduced fares. Despite this drop in the passenger business, the passenger train mileage was lowered by only 1 per cent. The loss in freight business was the worst we remember. The tonnage fell by 19·4 per cent. and the freight receipts by 12·6 per cent. There was, however, a decrease of 8·6 per cent. in the freight train mileage. On the other hand, despite the less business, the traffic moved more slowly, as the net ton-miles per engine hour fell from 436 to 429½.

REPORTS on all the railway accidents inquired into last year have now been published. The number of accidents was thirteen, and that is the lowest number ever recorded, except the twelve, six, and twelve respectively for the three war years 1916, 1917, and 1918. Of the thirteen accidents investigated last year, three were collisions between passenger trains, including one in a fog; four were collisions between passenger trains and freight trains or light engines; three were buffer stop collisions; and three were derailments of passenger trains. There were no inquiries into purely goods train accidents or into mishaps at level crossings. The only fatal case was that of a passenger killed in the collision of March 6th between a passenger train and a ballast train at Culgaith. In no instance was there a loss of life among the trainmen, and therein another record was established.

AN interesting point as to water troughs is revealed in the last blue-book on railway accidents. The guard of a goods train was sitting in his look-out when a volume of water from the tender of an express passenger train, which was picking up water, shattered the end and side windows of the guard's van, and the man was badly cut on the face, arms and legs by the flying glass, which was ⅛in. thick. The scoop for picking up the water was worked by a lever, and it is impossible, where a lever is used instead of a screw, to exert sufficient force to overcome the pressure of water and to raise the scoop when the tender has been filled. The surplus water is then forced out through the manhole at the back of the tender, and it was that volume of water which caused the injury in this case. The report concludes by observing that the advantages of the screw over the lever mechanism should not be lost sight of.

THE coroner's inquest into the deaths of the three passengers and the three railway servants—which latter included the driver and fireman—who lost their lives in the derailment at Leighton Buzzard on March 22nd was resumed and concluded on Friday, April 24th. We would first remind our readers that in our report of April 3rd of the Ministry of Transport inquiry, held by Colonel Mount, we mentioned that notice had been given that trains would be diverted from the down fast to the down slow line at Tring. Subsequently, however, that arrangement was changed, and the diversion was to be as between Leighton Buzzard and Bletchley, and a supplementary notice of that was issued. On that point we remarked that "a question for investigation is whether the enginemen of the express knew of the diversion at Leighton Buzzard; in other words, were they aware that they would not be able to continue on the down fast line on reaching Leighton Buzzard?" It is now admitted that a copy of the supplementary notice was not issued to the enginemen in question. Evidence was given to the effect that an examination of the engine since the accident had not revealed any feature that would lead to derailment. It was conceded that there was a general tendency for the smoke and steam in these large engines not to clear the cab, but no satisfactory remedy had been found. That class of engine had run 10,000,000 miles, but there had been no case of signals being overrun from that cause. Automatic train control might have prevented the accident. The jury returned a verdict of "Accidental death," owing to the driver failing to observe the signals and to have the train under control after passing the distant signals, but his negligence was not culpable. Recommendations were added as to the company pursuing the inquiries as to the smoke and steam and that automatic train control be adopted and signatures obtained for all notices.

Notes and Memoranda.

FOR the purpose of enclosing the site for a new 1000ft. quay at East London, South Africa, a cofferdam of steel sheet piling is being driven, which will require 1120 tons of steel in 50ft. lengths. The work is claimed to be one of the largest of its kind carried out in that country.

IT is suggested that the use of a Greathead shield for the tunnelling of a sewer in Johannesburg is an innovation for South Africa. The sewer is some ¾ mile long by 4ft. 6in. diameter at a depth of 90ft. In progress it met several pockets of mud, and so a Greathead shield was made locally to continue the work. The original shield was, of course, invented in 1874 and used in this country for the construction of the City and Southwark Subway, later known as the City and South London Railway.

ANOTHER merit of a tall chimney! In an area of 2500 square miles of the Sudbury district of Northern Ontario there are, it is officially stated, twenty-one primary and secondary triangulation stations of the Geodetic Survey of Canada, Department of the Interior, located on prominent hill tops from which the 510ft. smoke stack of the International Nickel Company of Canada, at Copper Cliff, may be seen. True bearings from each station to this chimney can be obtained, and these may be used for the accurate control of any mapping, engineering, or forestry operations that may be proposed without doing the expensive preliminary work usually necessary in other areas.

AN endeavour on the part of a foreign repairer of a trawler boiler to make assurance doubly sure resulted in the failure of the repair. The lower part of the back plate of the combustion chamber had been renewed before the vessel came into British ownership, and the horizontal joint was welded. Evidently with the idea of strengthening the weld, the repairer had added a series of elliptical pads, 9in. by 6in. and 1in. thick. The plate was $^{19}/_{32}$in. thick. The theory put forward to account for the failure is that the pads heated up more quickly than the plate and their consequent relatively greater expansion pulled the weld apart. Such reinforcement is not, of course, necessary in a properly made weld.

EVERY engineer is acquainted with two oxides of carbon, CO and CO_2. Now comes the suboxide, described in the following quotation from a recent Arthur D. Little *Industrial Bulletin*. Familiar as both CO_2 and CO are to everybody, we now have to reckon with a third, the suboxide of carbon, C_3O_2, with which only a few chemists have as yet even a speaking acquaintance. The suboxide is a gas at ordinary temperatures, but is easily condensed to a liquid boiling at 7 deg. Cent. and to a solid which melts at about 110 deg. Cent. below zero. It has an unbearable odour like mustard oil; its dilute vapour brings copious tears. In greater concentration it attacks the whole respiratory system with suffocating effect. It burns in air to CO_2, and with water it forms malonic acid. With ammonia, aniline and many other chemicals it unites to form a variety of compounds. Heated, it polymerises to a dark red solid.

IN the course of a paper on "Corrosion in Tanks and Tankers," by Messrs. J. F. King and J. L. Adam, read before the North-East Coast Institution of Engineers and Shipbuilders, the authors say that corrosion in whale oil tanks is less than in holds of ordinary ships, because the exposed steel becomes covered with a skin of congealed oil which takes the form of a thick fatty deposit like tallow. It is true that this deposit contains a certain proportion of corrosive acid, and that a certain amount of corrosion does occur behind the "skin," but it is a curious feature that scale or rust does not form on the material itself, and the coating seems to absorb such material as it dissolves. After delivering whale oil, the tanks are usually cleaned with a solution of caustic soda, coated with lime wash, and then filled with fuel oil for the whaling station. It is obvious that these working conditions are excellent and calculated to avoid the troubles consequent upon the carriage of water ballast.

APROPOS the house-warming of the precious metals refinery at Acton, of which we gave an account last week, the *Chemical Trade Journal* makes the following remarks as to the uses of the metals of the platinum group:—"Promising openings now seem apparent for palladium in dental work and in the manufacture of spectacle frames, but the most interesting of all its potential uses is the one now in course of development at the research laboratories of the Acton refinery—namely, the plating of white gold and silver to render these metals non-tarnishable. The ready tarnishing of silver under atmospheric influences has always been one of the main disadvantages of the metal, but the new process of palladium plating—which is rapidly approaching the commercial stage—entirely obviates this defect. Palladium-plated silver is likely to find its first uses for such purposes as microscope parts, spectacle frames, and automobile and aerodrome reflectors, but its eventual application to ordinary decorative and utilitarian silverware is well within the bounds of possibility."

THE official report on the explosion of a valve chest of a triple-expansion Lancashire mill engine discloses a remarkable state of affairs. The accident, which unfortunately resulted in the death of the engineman, is attributed to water hammer. The high-pressure Corliss steam valve was found jammed open by a ⅝in. stud. When the exhaust valve opened there would be free passage for high-pressure steam to the receiver. If there were water in the receiver it would be projected into the low-pressure valve chest and water hammer might very well smash it. That the receiver steam trap was inoperative and that water had consequently collected in the receiver is suggested by the following list of *débris* found in that vessel, some of which might have choked the trap connection. There were three ⅝in. studs; two ⅜in. nuts; a broken ⅜in. nut; three pieces of ⅛in. copper wire from 2in. to 4in. long; four irregular-shaped pieces of cast iron approximately 4in. by 1¼in. by 1¼in., 2in. by 2½in. by ⅜in., 1½in. by ⅝in. by ¼in., and 1¼in. by ⅝in. by ¼in.; one cylindrical piece of cast iron 1¼in. in diameter by ⅝in. thick; one 5in. nail; one steel splitting wedge 5in. long by 1¼in. wide; two pieces of steel 3in. by 1in. by ¼in., and 3in. by 1½in. by ¼in.; one ¼in. nut; one ¼in. bolt with nut; one ¼in. cheese-headed screw.

Miscellanea.

A RICH deposit of gold ore is said to have been found by Rhodesian Minerals Concessions in the Luano Valley.

IT is announced that the total attendance at the British Empire Trade Exhibition, Buenos Aires, was 1,443,914.

THE South Devon Regional Planning Committee is considering the construction of a bridge across the river Dart, at a cost of from £380,000 to £400,000.

AN electrolytic alkali factory is to be established at Eden, Carrickfergus, Ireland. It is proposed to encourage the gathering of kelp around the coast as a raw material.

A NEW Franco-Polish Company has been formed with a share capital of 15,000,000f. and registered offices in Paris for finishing the railway from the Polish Upper Silesian coalfield to the port of Gdynia.

A NEW wireless telegraphy service between the Sayville, Long Island, station of the Mackay Radio Company and the newly completed station of the Radio Corporation of Cuba at Camaguey, Cuba, has just been officially inaugurated.

DURING 1930 over 50,000 telephones were added to the network of Spain and 65 per cent. of the old manual exchanges were converted to the automatic system. The service, it is stated, provided a profit of £1,300,000, out of a revenue of £3,149,253.

A NEW chrome steel factory has been started near Oslo, Norway. It is equipped with six Rennerfelt furnaces and has a capacity of from 40,000 to 50,000 metric tons a year. The steel contains from 13 to 20 per cent. of chrome, which is imported from South Africa. The power requirements of the factory are some 10,000 kW.

THE capital invested in water power development in Canada was estimated by the Dominion Water Power and Hydrometric Bureau, Department of the Interior, to amount to over 1390 million dollars on January 1st, 1931. The last year for which official figures are complete for all industries is 1928, and these show that the amount of capital invested in water power was exceeded only by that in agriculture and in steam railways.

WE learn with pleasure that one of the largest electrical undertakings on the Continent has just acquired the rights in an entirely British system of house warming and will introduce the system in France, Italy, Spain, Belgium, Luxemburg and Switzerland. Another electrical syndicate is negotiating for rights for other countries. The new system is an invisible electric ceiling radiator, emitting dull rays, which automatically cuts itself off if the room becomes 1 deg. warmer than the user likes it to be.

THE mercury vapour boiler at the South Meadow station of the Hartford Electric Light Company, U.S.A., has been shut down after a year's service for retubing, as it had been found that some of the loose cast iron filler pieces, used to reduce the volume of mercury in the boiler, tended to wear the tubes on account of vibration. Tubes of a new design are to be used. During the year the set has produced 135 million kilowatt-hours at a net consumption of 0·72 lb. of 14,000 B.Th.U. coal per kilowatt-hour.

THE fourteenth Swedish Industries Fair at Gothenburg will open on May 9th and close on May 17th. It is divided into two principal groups, viz., the Industrial Fair and the Building Fair. This last comprises all concerning constructions for the town and for villas, the arrangement and furnishing of a house, &c.; the first one contains all kinds of art productions and manufactured goods. Besides, one finds in the Fair sections for handiwork, works of art, home-industry products and inventions. Facilities concerning passports are allowed for the foreign travellers to the Fair. Rooms and lodgings are provided through the Fair's boarding department office; address, Nordisk Resebureau, Göteburg.

IN order to facilitate the development of coal mining in the Huainan area, south of the Huai River in Anhwei Province of China, the National Reconstruction Commission is planning the construction of a light railway leading from the mining district past Hofei to the important river port of Wuhu, on the Yangtze River. The proposed railway is about 130 miles long; cost of construction is estimated at 4,000,000 dollars. The Huainan coal mine possesses abundant anthracite deposits. When the mine was first opened the daily output was about 100 tons of coal, but since then the yield has been increased to as much as 3000 tons daily. According to tests made, the quality of the coal is even better than the product of the Chunghsing Mine in Shantung.

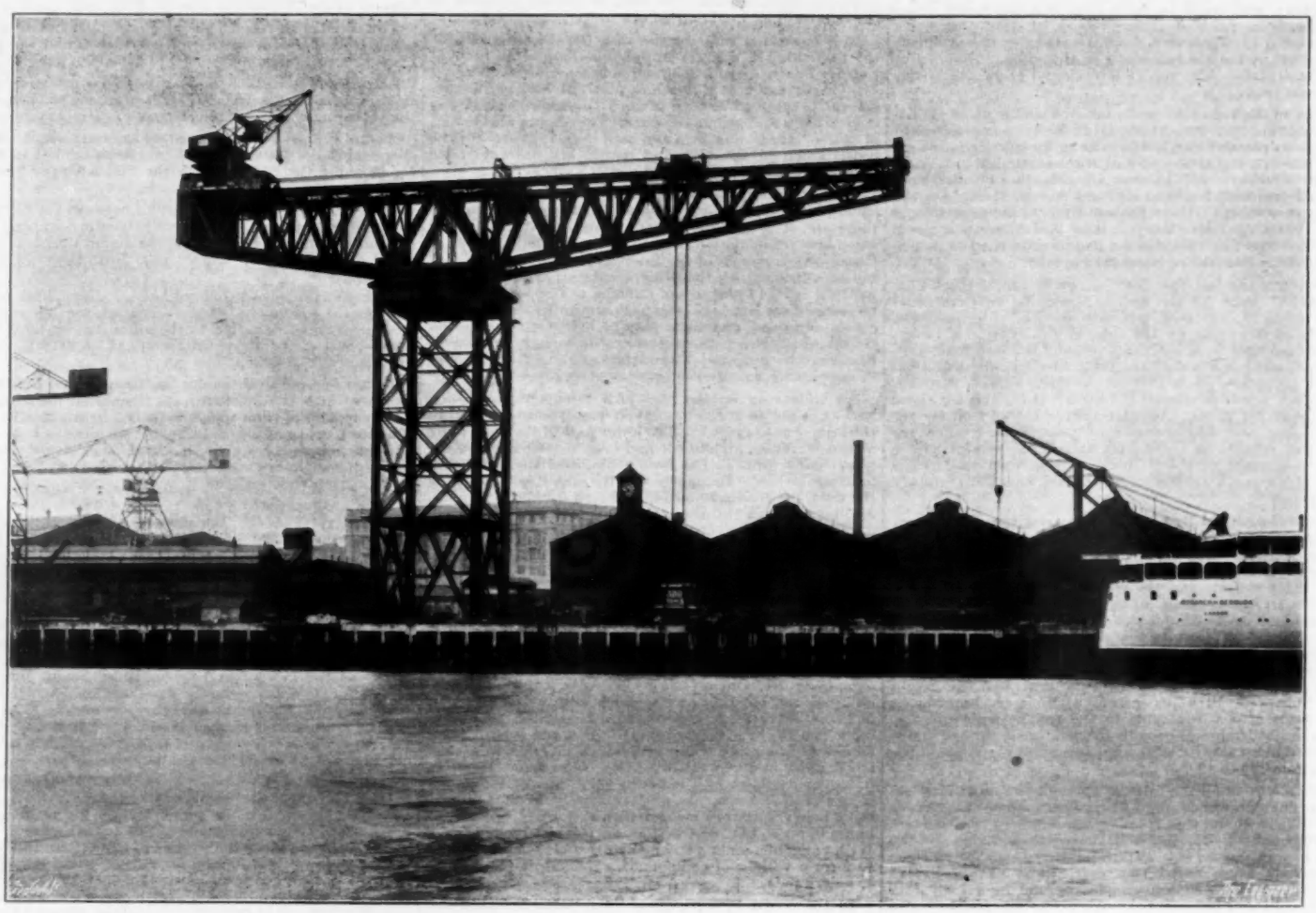
A HEAVY oil aero-engine designed by Professor Junkers was demonstrated at an aerodrome near Berlin on April 22nd. It was a six-cylinder engine of 720 horse-power, and the makers claim for it a 47 per cent. increase in flying range and a 100 per cent. increase in loading capacity as compared with a petrol engine of similar power. The engine weighs 1760 lb. and was mounted in a nine-passenger monoplane which is ordinarily fitted with three petrol engines. The machine is stated to have started easily and to have taken off smoothly on its brief trial flight. Although the weight of the engine is more than that of some petrol engines of a similar size, it is said to use only two-thirds as much fuel per flying hour. The working costs are stated to be 65 per cent. lower than in the case of petrol engines.

IT is reported in *Indian Engineering* that an expedition, led by Lieut.-Col. J. E. Stewart, will shortly make an aerial survey of a large part of Eastern Turkestan. Special permission, the report states, has been obtained from the Indian Government, for the flying over certain area prohibited for aeroplanes, which comprises part of the intended route. It is intended to fly along the air mail route to India and cross the Karakoram Mountains at a height of 13,400ft. to the base at Yarkand, and return across the Himalayas at a height of 18,600ft. The object of the expedition is to prove the possibility of improving transport facilities eastwards from East Turkestan; to create a channel for trade through India; and to discover areas which may be profitably developed. At present most of the produce of East Turkestan goes out by the easterly route to the Chinese coast, and the journey of 2500 miles takes about five months.

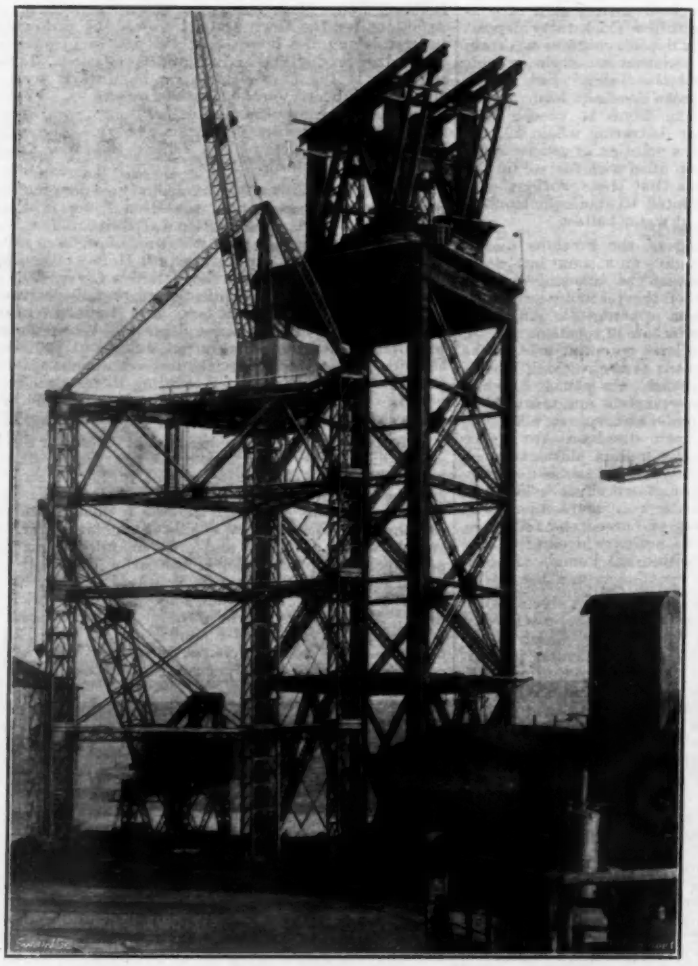
250-TON ELECTRIC HAMMERHEAD CRANE

SIR WILLIAM ARROL AND CO., LTD., GLASGOW, ENGINEERS

(*For description see page 492.*)



THE COMPLETED CRANE CARRYING TEST LOAD



THE TOWER COMPLETED—ERECTION OF THE CANTILEVER BEGUN

ERECTION OF THE CRANE NEARING COMPLETION

The Engineer

Annual Subscription Rates

(Including postal charges).

Subscriptions will be accepted by the Publisher direct or through a newsagent at the rates and in the currencies stated below :—

BRITISH ISLES	£3	5	0	
CANADA	£3	3	0	Thick Paper edition.
	£2	18	6	Thin Paper edition.
ABROAD (except Canada)	£3	7	6	Thick Paper edition.
	£3	3	0	Thin Paper edition.

AFRICA	Central News Agency. All Branches
* £3 7s. 6d.	CAPE TOWN : Wm. Dawson and Sons, Ltd.
† £3 3s. 0d.	29–31, Long-street (Box 489)
	JOHANNESBURG : C. Juta and Co.
ARGENTINE	BUENOS AIRES : Mitchell's Book Store, 576,
* £3 7s. 6d.	Cangallo
† £3 3s. 0d.	
AUSTRALIA	Gordon and Gotch (Australasia), Ltd. All
* £3 7s. 6d.	Branches
† £3 3s. 0d.	MELBOURNE : Robertson and Mullens, Elizabeth-street
BELGIUM	BRUXELLES : W. H. Smith and Son, 78–80,
* Fr. 590	Rue du Marché-aux-Herbes
† Fr. 550	
CANADA	American News Company, Ltd. All Branches
* $15·25	MONTREAL : Gordon and Gotch, Ltd., 334,
† $14·25	Notre Dame-street, W.
	TORONTO : Wm. Dawson and Sons, Ltd., 87, Queen-street East
	TORONTO : Gordon and Gotch, Ltd., 81, Queen-street West
CEYLON	COLOMBO : Wijayartna and Co.
* Rs. 44·5	
† Rs. 41·5	
CHINA	HONG KONG : Kelly and Walsh, Ltd.
* $37	SHANGHAI : Kelly and Walsh, Ltd.
† $34·5	
EGYPT	CAIRO : Express Book and Stationery Store,
* £3 7s. 6. (Pt. 330)	9, Chareh Maghrabi
† £3 3s. 0d. (Pt. 308)	
FINLAND	HELSINGFORS : Akademiska Bokhandeln,
* M. 650	Alexandersgatan, 7
† M. 605	
FRANCE	PARIS : Boyveau and Chevillet, Rue de la
* Fr. 418	Banque, 22
† Fr. 390	PARIS : Librarie Berger-Leverault, 229, Bld. St. Germain
	PARIS : Brentano's, 37, Av. de l'Opera
	PARIS : Dunod, 92, Rue Bonaparte
	PARIS : W. H. Smith and Son, 248, Rue de Rivoli
GERMANY	BERLIN–LICHTERFELDE–WEST : H. Hermanns, Dahlemer Strasse 64 A
* R. mks. 70·00	WESTERN GERMANY : Fritz Rehfus, Blumenthalstrasse 10, Cologne
† R. mks. 65·00	LEIPZIG : K. W. Hiersemann, Konigstrasse 29
HOLLAND	ROTTERDAM : Hector's Boekhandel, Noordblaak 59
* Fl. 41·00	ROTTERDAM : Techn. Boekhandel, "Plan C,"
† Fl. 38·00	Gelderschestraat 4
INDIA	BOMBAY : Thacker and Co., Ltd.
* Rs. 45	CALCUTTA : Thacker, Spink and Co.
† Rs. 42	
ITALY	MILAN : Ulrico Hoepli
* Lire 300	ROME : Maglioni and Strini, 307, Corso
† Lire 280	ROME : Fratelli Treves, Corso Umberto I, 174
	ROME : Fratelli Bocca
	TURIN : Rosenberg and Sellier, v. Maria Vittoria 18, and their Branches at Naples and Rome
JAPAN	Maruzen Co. All Branches
* £3 7s. 6d.	
† £3 3s. 0d.	
JAMAICA	KINGSTON : Educational Supply Co.
* £3 7s. 6d.	
† £3 3s. 0d.	
NEW ZEALAND	AUCKLAND : Whitcombe and Tombs, Ltd.
* £3 7s. 6d.	Gordon and Gotch, Ltd. All Branches
† £3 3s. 0d.	NAPIER : J. Wilson Craig and Co.
RUSSIA	LENINGRAD : Mezhdunarodnaya Kniga, Prospect Volodarsky, 53 A
* £3 7s. 6d.	MOSCOW : "Litiadat," Kousnetsky Most, 5-15
† £3 3s. 0d.	
STRAITS SETTLEMENTS	SINGAPORE : Kelly and Walsh, Ltd.
* $29·25	
† $27·25	
SWEDEN	STOCKHOLM : A/B Wennergrens Journal-expedition, Stockholm 1
* Kr. 61·00	STOCKHOLM : A/B C. E. Fritzes Kungl., Hofbokhandel, Fredsgatan, 2
† Kr. 57·00	
SWITZERLAND	BERNE : Joh. William De Groot, Laupenstr. 5
* Fr. 85·20	ZURICH : Rosa Leibowicz, 4, Ankerstr.
† Fr. 79·50	
UNITED STATES OF AMERICA	International News Co., 131, Varick-street, New York, N.Y., and all Branches
* $16·40	Entered as second-class matter at the Post Office,
† $15·25	New York, N.Y., December 12th, 1896, under the Act of March 3rd, 1879 (Section 397, P.L. & R.)

* *Thick Paper.* † *Thin Paper.*

These rates are liable to alteration if exchange fluctuations require it.

*** READING CASES, *to hold two copies of* THE ENGINEER, *cloth sides and leather backs, can now be supplied at 4s. 9d. each, 5s. 3d. post free.*

"THE METALLURGIST."

This Supplement, which deals with the Science and Practice of Metallurgy, both ferrous and non-ferrous, is published free with the last issue of THE ENGINEER in each calendar month.

ADVERTISEMENTS.

The charge for Classified Advertisements is 1/- per line up to one inch—minimum charge 4/-; those occupying one inch or more at the rate of 12/- per inch. Orders must be accompanied by a remittance. The rates for Displayed Advertisements will be forwarded on application. Classified Advertisements cannot be inserted unless delivered before TWO o clock on Thursday afternoon (the day before publication).

Letters relating to the Advertisement and the Publishing Department of the Paper are to be addressed to the Publisher, all other letters are to be addressed to the Editor of THE ENGINEER.

THE ENGINEER DIRECTORY.

This Directory, which is published annually in the interests of advertisers in THE ENGINEER, may be obtained free of charge on application to the Publisher.

Postal Address, 28, Essex-street, Strand, London, W.C. 2.
Teleg. Address, "Engineer Newspaper, Estrand, London."
Tel.: Central 6565 (8 Lines).

By arrangement with Reuter's Engineering Service, THE ENGINEER *contains the latest news from all parts of the world which is likely to be of interest to engineers.*

Contents.

THE ENGINEER, May 1st, 1931.

	PAGE
A SEVEN-DAY JOURNAL	475
THE EFFECT OF USE ON THE PROPERTIES OF MOTOR OILS. (Illus.)	476
INSTITUTION OF MECHANICAL ENGINEERS	478
EFFICIENCY IN THE TOOL DEPARTMENT	479
POST-WAR LAND TURBINE DEVELOPMENT. (Illus.)	481
7000 B.H.P. DOUBLE-ACTING TWO-STROKE MARINE OIL ENGINE. (Illus.)	484
MAIN LINE ELECTRIFICATION	485
A NEW VIEW ON POLITICS AND SCIENCE	486
MARINE WEEK AT PETTERS, LTD., YEOVIL	486
RAILWAY AND ROAD MATTERS	487
NOTES AND MEMORANDA	487
MISCELLANEA	487
LEADING ARTICLES—	
Main Line Railway Electrification	489
LITERATURE	490
OBITUARY—	
Major H. M. Leaf	490
Major A. B. S. Steinmetz	490
J. H. Melloy	491
J. P. Bailey	491
SIXTY YEARS AGO	491
HUNGARIAN RAILWAY ELECTRIFICATION SCHEME. (Illus.)	491
A 250-TON ELECTRIC HAMMERHEAD CRANE. (Illus.)	492
A NEW SINGLE-DECK MOTOR COACH. (Illus.)	494
LETTERS TO THE EDITOR—	
The Airship Experiment	496
The Electrification of Railways	496
The "Queen of Scots" Train	496
LONG-DISTANCE TELEPHONY	496
PROVINCIAL LETTERS—	
The Midlands and Staffordshire	497
Lancashire	497
Sheffield	498
North of England	498
Scotland	499
Wales and Adjoining Counties	499
PERSONAL AND BUSINESS ANNOUNCEMENTS	499
CONTRACTS	499
CATALOGUES	499
CURRENT PRICES FOR METALS AND FUELS	500
FRENCH ENGINEERING NOTES	501
BRITISH PATENT SPECIFICATIONS. (Illus.)	501
FORTHCOMING ENGAGEMENTS	502

TWO-PAGE SUPPLEMENT—250-TON ELECTRIC HAMMERHEAD CRANE.

NOTICES TO READERS.

*** *If any Subscriber abroad should receive* THE ENGINEER *in an imperfect or mutilated condition, he will oblige by giving prompt information of the fact to the Publisher, with the name of the Agent through whom the paper is obtained. Such inconvenience, if suffered, can be remedied by obtaining the paper direct from this office.*

*** *All letters intended for insertion in* THE ENGINEER *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

*** *No undertaking can be given to return drawings or manuscripts; correspondents are therefore requested to keep copies.*

THE ENGINEER.

VOL. CLI No. 3929

MAY 1, 1931.

Main Line Railway Electrification.

OUR first reaction to the report of Lord Weir's Committee on the Electrification of British Railways is that the scheme outlined is not in any likelihood of being adopted. It would cost the railways 261 million pounds, and the Central Electricity Board and other authorised undertakers 80 million pounds, it would not be completed in a period of less than twenty years, and the estimated surplus after meeting interest charges on the capital is only 2 per cent.—a margin, as the reporters themselves admit, "too narrow for the risks and contingencies involved." But there is another side to the picture. The figure of 2 per cent. is an accountant's margin; it is, to quote the report, "the crudest and most unimaginative expression of the economic situation." It is based upon present conditions and takes into consideration neither the changes beneficial to the railways themselves which might result from electrification, nor the collateral effects upon the industries of the country. Such things cannot be estimated accurately, and the opinions of those who study the question will depend upon the direction in which their imaginations turn. On the one hand, we may have those whose faith in electricity is so profound that they will have no difficulty in visualising all and more than the Committee suggests, and on the other, those who are less ready to believe that electricity can achieve everything and are convinced that means of railway transport as economical as electrification and without its disadvantages are yet possible. Between these two the scheme—as a single magnificent unit—is likely to fall to the ground, for it must be admitted that the Committee's case for electrification depends upon factors which cannot be accurately estimated, and that without a lively imagination the return "would not appear from a business point of view to warrant the adoption of a scheme of such exceptional magnitude."

The Committee, ever since its appointment in September, 1929, has been known familiarly as the Main Line Electrification Committee, and as a matter of fact the terms of reference directed it "to examine into the economic and other aspects of the electrification of the railway systems in Great Britain, with particular reference to main line working." It elected, however, for excellent reasons, to review the railway system as a whole and not main line working alone. To cover this wide aspect of its duties it adopted as a definition of Main Lines "all railways in this country not yet electrified or in process of electrification, with the exception of some spur or branch lines carrying little traffic." On national grounds it is possible to defend this large view of railway electrification, but that it adds to the difficulties of the investigation cannot be denied. For, say what we will, the suburban and main line problems are not the same. No one any longer questions the desirability of the electrification of railways around and through great cities. The services are practically tramway services, the bulk of the traffic is the conveyance of passengers, and there are very distinct peaks in the morning and evening, when every advantage of electric traction is manifested. In main line operation the particular qualities of electric traction have no outstanding merits. The traffic density, taken as a whole, is much less, so that the rapid handling of trains is necessary only in particular localities and on particular occasions, the stopping places are many miles apart, and the benefits of rapid acceleration are small, the roads mainly run through open country, where the emission of smoke is of no consequence, and, finally, a large proportion of the traffic is freight for which economy of operation is the only advantage that could accrue from electrification. Whilst we cannot but admire a scheme which visualises the complete electrification of Great Britain, and whilst we are ready to admit that a much stronger argument for electrification can be produced when the scheme is so expanded, we cannot avoid the conclusion that it introduces an element of speculation and in the long run may reduce the chances of the adoption of the Committee's proposals. For what it comes to is no more nor less than this, that there is no conclusive argument for the electrification of main lines, and, on a current balance sheet, which may or may not be a trustworthy guide, the electrification of them would be rather inimical to the electrified suburban lines than otherwise, for the positive estimated return for the complete electrification scheme is only 2 per cent., or considerably less than the returns which may be justly put to the credit of the electrified suburban lines. It is, we are quite ready to concede, well known that the electrification of suburban lines has had results which could not be forecast in a balance sheet. Would the same thing be true of main lines? That is a very important question; and to it we have nothing but speculative answers.

It has often been claimed for the electrification of main lines that by the replacement of the inefficient steam locomotive it would effect economies. We find little confirmation of that view in the report. On the contrary, "All our investigations show," says the Committee, "that on the item of fuel comparatively little saving will be made by the substitution of electrical energy in place of coal (at existing prices), and even though a saving of about 50 per cent. may be realised on the total of 1·8 pence for minor items (maintenance of locomotive buildings, water, lubrication, &c.), the net gain will be comparatively small." And again, "In striving to obtain reliable comparative costs of steam and electric traction in actual working we have been entirely unsuccessful." These conclusions would seem to put an end to the familiar argument. But in fairness we must not lose sight of the case to which the Committee pins its faith, namely, that whilst electrification of any one main line could not be justified, the complete electrification of all the railways in the land would be profitable. To ascertain the differences between the alternatives it put two cases before Messrs. Merz and McLellan:—One, part of the London and North-Eastern Railway, in which complete electrification was postulated; and the other, part of the London, Midland and Scottish Railway, in which only partial electrification was considered. For the former the estimated return on net capital is 7·22 per cent., and for the latter 2·5 per cent. Arguing from the less to the greater, the conclusions are reached "(*a*) That except where some special conditions obtain, the carrying out, or even the investigation of, limited schemes, involving as they must the dual working of steam and electricity, is unlikely to prove worth while. (*b*) That there is only one way by which the full benefit of railway electrification can be obtained in Great Britain, and that is by the complete substitution of steam haulage by electricity." The second of

these two conclusions is the most interesting and pregnant statement on the electrification of British railways that has ever been made. If it is right it justifies in great measure all those who have opposed main line electrification, for never before has the "complete substitution of steam haulage by electricity" been seriously contemplated. Furthermore, a fair deduction is that unless the country is prepared to set its hand to a scheme which will cost some 261 million pounds and take twenty years to complete, then the electrification of main lines had better be left alone.

From what we have said it will be seen that the policy of the Committee may be expressed briefly, and with but little injustice, as "All or None." What is proposed is, in fact, a national scheme of railway electrification. The implications are interesting. It is hardly conceivable that a plan of such magnitude could be carried out without the direct assistance of the Government, and there is a probability, far from remote, that it would be employed for the Nationalisation, whole or partial, of the railways of this country. That is an eventuality which will be unwelcome to a great many people. Again, the ultimate success of the scheme turns upon the ability of the "Grid" to supply current at a halfpenny or less per unit. That desideratum is not yet in sight, and, as we understand it, cannot come into sight until the consumption postulated for an electrified country is realised. For the time being it must remain a problematical figure. Finally, the recommendation of complete electrification of practically all railways at the end of twenty years pre-supposes that in that period—a long one in the annals of the development of inventions—no better method of hauling trains will be found. The Committee makes the statement that "from all the evidence we conclude that none of the alternatives to steam which we have examined is either sufficiently developed to warrant widespread adoption as an alternative to the steam locomotives of to-day, or even holds the probabilities of development into an effective alternative to electrification for main line purposes. We would say, however, that, in the case of oil-electric units, these may be regarded as possible substitutes for steam on lightly loaded branch lines, and more particularly so in conjunction with a general electrification of main lines." If we may venture to say so, that statement shows a little lack of scientific imagination. The high-speed, heavy-oil engine is only at the beginning of its career. Many firms are engaged upon its developments, and its adaptation for railway traction is being carefully investigated. Great possibilities lie in front of it and we shall be, indeed, surprised if the position which it now holds is not very greatly improved before twenty years are out. It certainly cannot be dismissed as an alternative to main line electrification. It may, however, be said, very justly, that progress with great schemes would never be possible if the fear that their advantages would be nullified by future progress were allowed to have preponderating influence. Yet we cannot forget that the power to jettison any scheme, plant or equipment as soon as something better is available is amongst the greatest of the steps of progress. To commit the country to a scheme of such vast magnitude as that adumbrated by Lord Weir's Committee would unquestionably not only remove that power, but would certainly tend to arrest any developments in other directions. In face of that very real danger, may we not ask if it is not wiser to leave the problem of the best and most economical means of main line operation in the hands of the railway companies? They are investigating improvements in independent "tractors"—we use the Committee's term—and an important experiment in main line electrification is well advanced. They are familiar with what has been done in other lands and are alive to the conditions which prevail in this country We are confident that they may be trusted to do what is really best for the railway system and to do it without committing the kingdom to an enormous expenditure, a prolonged effort, and a policy which may not be the best when its fulfilment is attained.

One word remains to be said in conclusion. We have rarely read any report, and never a report on railway electrification, which was so absolutely fair as this Report of Lord Weir's Committee. It is a model of its kind and reflects credit of the highest order upon the four gentlemen—Lord Weir, Sir Ralph Wedgwood, Sir William McLintock and Colonel A. C. Trench (Secretary)—who prepared it. They succeeded in securing the co-operation of all the parties concerned, amongst whom the great railway groups must be particularly mentioned. Their report is based, therefore, upon the opinion, possibly unanimous, of those best qualified, in the whole country, to reach a wise conclusion. That conclusion is, let us repeat once more, that if full advantage is to be derived from the electrification of the railways of Great Britain, then every line in the country must be electrified. The scheme is a huge one, and if it fails to be adopted it will succumb under its own weight and not because of any weakness in the arguments by which it is supported.

Literature.

Limestones: Their Origins, Distribution and Uses. By F. J. NORTH, D.Sc., F.G.S. London: Thomas Murby and Co., 1, Fleet-lane, E.C. 4. Price 16s.

MANY substances are generically called limestones, but all the bodies to which the name is applied contain calcium carbonate as an essential constituent. A pure limestone contains 98 to 99 per cent. of calcium carbonate. An impure limestone may contain anything up to 50 per cent. of sand, clay, magnesia, or other substances, or mixture of substances. If the non-calcium carbonate portion exceeds 50 per cent. of the total, the substance is not usually regarded as a limestone, but is known as a calcareous sandstone, a calcareous clay, and so forth.

It will be inferred therefore that the term limestone covers a wide range of bodies. That range is scarcely more extensive than the uses to which limestone is put by man. A book on the origin, distribution and uses of limestone cannot, it is clear, have a narrow interest. From the geological point of view, it must dive deeply into natural history. From the economic standpoint it must consider industries as diverse as agriculture, metallurgy, glassmaking, Portland cement manufacture, road making, and house building, in all of which limestone, either as quarried or after treatment, is a primary material. Dr. North has provided us with a book which in every way is in keeping with the vast importance of limestone as a constituent of the earth's surface, as an element essential to nearly all forms of life, and as a substance on which man is dependent in many of his most important undertakings. His book is very far from being merely a treatise on a specialised section of geology. To the geological student desirous of making a particular study of the limestone formations of the British Isles, the work may be fully recommended. To those interested industrially in the quarrying, after treatment, and use of limestone, it should be of the highest value. But it is perhaps in its appeal to the general scientific reader that the book possesses its chief note of distinction.

Limestones occur in this country in the rocks of all the geological systems, and all are of commercial or economic importance, except perhaps those of the pre-Cambrian, the Cambrian, and the much younger Triassic systems. A survey of the subject is therefore not confined to a study of a limited period of geological time, but covers it all. In Dr. North's hands it has been made, in effect, the keynote to as delightful an exposition of general geological facts and principles as it has ever been our good fortune to peruse. As Keeper of the Department of Geology in the National Museum of Wales at Cardiff, he is not only fully qualified to write on any geological subject, but in view of the varied occurrences of limestone in Wales, he is particularly able to deal with this specialised branch of the science from first-hand knowledge.

The book is divided into three main parts. In the first the author discusses the nature, origin, and varieties of limestone. In the second, he describes the distribution of limestone in the British Isles, each geological system and the limestones which it produced being dealt with in a separate chapter. In the third part the relationship of limestone to scenery, agriculture, water supply, and industry is set forth. Throughout the treatment there will be found numerous items of information of general scientific, archæological, and historical interest. Next to the high literary standard of the author's style, the reader will be attracted by the large number of interesting and excellently reproduced illustrations which the book contains.

The Theory and Design of Illuminating Engineering Equipment. By L. B. W. JOLLEY, J. M. WALDRAM, and G. H. WILSON. London: Chapman and Hall. Price 45s.

So much has been written on illumination that any addition to the literature on the subject may appear to be uncalled for, but the authors of this extensive and instructive volume have attempted to attack the subject from an aspect not yet treated in detail in any published book, so far as they are aware. While other writers have dealt with the science or art of illuminating engineering, Mr. Jolley and his colleagues consider the equipment which must be employed, if good practice in lighting is to be attained. Considerable attention is paid to light sources, but only electrical sources are considered. In that part of the volume which deals with lighting equipment, all phases of design are reviewed in great detail. It appears from the Preface that when the authors came to consider their terms of reference, as specified in the title, they concluded that they could not wholly restrict themselves to them. While they have tried to omit references to lighting *per se*, it has not always been possible to refrain from discussing lighting apart from the equipment.

When it is stated that, including the index, the volume contains over 700 pages, it will be realised that the subject is covered pretty thoroughly. All the authors are connected with the General Electric Company's research laboratories at Wembley, and are therefore in a good position to write on this important subject, but judging from the long list of acknowledgments at the end of the Preface, much information has been drawn from other sources. A good deal of attention is paid to the various kinds of electric lamps, including filament, tungsten arc, carbon arc, mercury vapour, cold cathode, and hot cathode lamps, whilst lighting problems dealt with in the early part of the volume include interior lighting, street lighting, flood lighting, and show window and display lighting. Signals and beacons, air port, and airway, and stage lighting are also covered.

We shall not attempt to catalogue here the titles of all the chapters, which cover a very wide field. Some of the most important from the designing engineer's point of view are those on the design of reflecting profiles, the design of diffusing equipment, of refracting equipment, and of projectors. Although the authors have found it impossible to consider every phase of the subject, they have succeeded in producing a volume that should prove of considerable value to many who have to deal with practical illumination problems, and even automobile lighting has not been entirely neglected. Those interested in stage lighting and advertisement sign lighting and cinema studio equipment are also catered for. As the authors point out, it is only lately that attention has really been called to the necessity for good lighting. Bad illumination is responsible for inefficiency in many factories and offices, and if this new and extensive volume helps to raise the general standard of illumination it will serve a very useful purpose.

Obituary.

MAJOR H. M. LEAF.

WE regret that we have to announce that Major Henry Meredith Leaf, D.S.O., was knocked down by an omnibus in Cockspur-street last Thursday, April 23rd, and died soon after he was admitted into Charing Cross Hospital. He was the son of Mr. F. H. Leaf, was born in Streatham on October 18th, 1862, and received his education at Marlborough, later entering Trinity College, Cambridge, where he obtained his engineering training. He also studied for some time at University College, London. While he was serving his pupilage with Cromptons, Ltd., of Chelmsford, he joined the Institutions of Mechanical and Electrical Engineers. His experiences in carrying out lighting contracts for large towns and factories in England led him to write a book on the internal wiring of buildings. For some time his work took him abroad, and he became superintendent of the central electric station at Gothenburg, in Sweden, and later of that of Le Mans, in France. As a Captain in the London Electrical Engineers, he served in the South African War, and his services during the Great War will be remembered by many of his friends. For them the D.S.O. was awarded to him. Outside his professional duties, he was a great enthusiast for games, playing tennis, rackets, and cricket with considerable success. He had many friends who will feel his loss acutely, for his personality was such that all who came into contact with him came under the influence of his charm. In 1917 he was married to Anna Maria Elizabeth, a daughter of the late Dr. Robert Needham Cust, a descendant of Lord Brownlow.

MAJOR A. B. S. STEINMETZ.

BY the death of Major Arthur Bernard Samler Steinmetz, of Bedford, on Saturday last, at his home, following a short illness, we lose one of the country's foremost experts in tillage, who had almost a lifelong connection with J. and F. Howard, Ltd., of that town. Major Steinmetz, who was born in 1874 at Bedford, was the son of the late Dr. H. Steinmetz, for many years the German Master at the Grammar School. After completing his education at the Grammar School young Steinmetz was apprenticed at the Britannia Works of J. and F. Howard, Ltd., and with the exception of a short period during which he was engaged in business on his own account he remained with the firm until his death. He made a very close study of the agricultural side of his firm's activities and was the chief of its experimental design department. In the course of his varied work he made extensive visits to practically all the European countries and to America, Cuba and India, where he studied first hand the various local problems relating

to the mechanical side of agriculture. He was a clever engineer, and was granted many patents in connection with agricultural machinery. One of his principal hobbies was the construction of models of ploughs and other implements, and many of his productions are to be found among the exhibits which are displayed at the South Kensington Museum. He was specially interested in plough design, and his collection of models included a range which goes back to before the Christian era. Major Steinmetz was very popular with his colleagues and the men, and his loss will be keenly felt by Messrs. Howards and a wide circle of friends. He was an associate member of the Institution of Mechanical Engineers, and was a keen supporter of the Volunteer and, later, the Territorial movement, beginning his military career at Bedford Grammar School in 1888 and serving with distinction both in the South African campaign and in the Great War with the Royal Engineers.

JAMES HENRY MELLOY.

WE regret to have to record the death of Mr. James Henry Melloy, which took place at his home in Menai Bridge on April 19th. Mr. Melloy was associated for many years with Wm. Muir and Co., Ltd., Manchester, during which time he was responsible for many developments in machine tool design. He received his general education at the Manchester Grammar School, and continued his technical education at evening classes connected with the Manchester Municipal Technical School, securing the gold medal of the City and Guilds of London Institute. Later he was appointed lecturer at the Technical School evening classes on machine design and construction. He served his apprenticeship with Craven Brothers, Ltd., Manchester, in the machine tool drawing-office, and later occupied a position in the works. Subsequently, he went to John Hetherington and Sons, Ltd., as works manager, and afterwards returned to Craven Brothers, Ltd., for a short period. He joined Wm. Muir and Co., Ltd., as general manager in 1902, and was later appointed managing director, which position he held until 1929, when he retired, retaining his seat on the board of directors. Mr. Melloy was interested in many developments in machine tool design, his name being connected with several patents, the more notable of which were the introduction of the inner spindle in horizontal boring and surfacing machines, improvements in gear hobbing machines as used more particularly for cutting turbine reduction gears, in connection with which several patents were taken out, and puncher slotting machines, first patented in 1910. He was closely identified with the improvement of machines for the production of turbine reduction gearing and contributed a paper on the subject to the North-Western Section of the Institution of Mechanical Engineers in 1922. Incidentally, it may be mentioned that the house in which Mr. Melloy died at Menai Bridge is the same in which Telford lived during the construction of the bridge.

JOSEPH PETTAR BAYLEY.

AT the annual general meeting of Guest, Keen and Nettlefolds, Ltd., held on Wednesday last, April 29th, at Birmingham, Sir John Field Beale, the chairman, made reference to the great loss which the company had sustained by the recent death of the manager of its Cwmbran Works, Mr. J. P. Bayley. Mr. Bayley, who was originator of the company's patented composite steel sleeper, was on his way back from India, which country he had visited on the firm's business, when he was taken ill with appendicitis on the voyage home, and after two operations died in a nursing home at Gibraltar on Friday last, April 24th. He was only forty-five years of age, and was a native of Horsehay, Shropshire, his father being Mr. H. R. G. Bayley, the managing director of the Horsehay Company, Ltd., of Horsehay, Wellington, Shropshire. Mr. Bayley was a most capable and industrious worker, and he took a keen interest in the welfare of the men. His death leaves a serious gap in the company's organisation, and is deeply regretted by a wide circle of friends.

SIXTY YEARS AGO.

Two pictures of life in the mid-Victorian era are presented to the modern reader in our issue of May 5th, 1871. The first one shows us the miner at work in South Wales. In the fiery mines of that district ventilation was still carried out by means of a furnace at the foot of an upcast shaft. Fans represented a new-fangled idea and were unwillingly adopted, in spite of the fact that disasters were known to have been caused by the ignition of gas at the ventilating fire. In some of the pits the men still used naked lights, and in one at least it was the practice to tap a blower and use it as a gas jet. Several blower jets were known which had been alight in the workings for years. There were not wanting rules and regulations for the guidance of firemen and overmen, but frequently the education of the men had been insufficient to enable them to read the instructions. Disasters were of common occurrence. During the preceding five years four of the principal explosions—two of them at the same colliery—had cost the loss of 309 lives. We had spoken to colliers who had been in, not one, but several explosions, and we had stood at the shafts of the Gethin and Ferndale pits immediately after a disaster had occurred. Could not science or the expenditure of more wealth, we asked, prevent these desolations? Our sympathies were actively on the side of the human gnomes who toiled in the muddy pools of the workings in order that their wives and children might have bread and the world and commerce and civilisation prosper, who at any moment might be the victims of a tragedy, who, if they survived to an infirm, rheumatic old age, had nothing but the workhouse wards and a pauper's grave before them. . . . Meanwhile science was displaying her most recent progress at South Kensington. The International Exhibition of 1871 had been opened with a display of ceremony which was in itself an exhibition. Never before had we seen so many cocked hats in so small a space. Headed by the Prince of Wales, who "lost no opportunity of showing himself gracious," the aristocracy, the diplomacy and the powers, military and civil, had assembled for the occasion in the belief that they were going to do something to promote the arts and sciences. The deception, we wrote, was harmless. South Kensington wanted a demonstration and had got it. The ladies, in azure and rose, "handsomely fulfilled the mission of the hour and appeared in attire which in some instances was splendid and in almost every case was tasteful." These surely were the golden days for science and art, when royalty, beauty, wealth and power came together in honour of an exhibition of selected works of fine and industrial art and scientific inventions. The Nawal Nazim of Bengal was there in cloth of gold, and Lord Elcho, champion of the Volunteers, in sober grey. There, too, was the Bishop of Winchester, looking well for a sick man—rumour had it that he had excused himself from preaching the day before. Present also were General Sir James Scarlett, in uniform worthy of his name; Musurus Bey, "who by this time must almost fancy himself an Englishman;" Earl Granville, Mr. Secretary Bruce, Mr. Goschen, and Mr. Disraeli, in his Windsor uniform, thinking perhaps as much about the Budget as about South Kensington. It was a pleasant gathering, but behind it there was a feeling of uneasiness. It was difficult to be light-hearted while the air of Europe was rank with sulphur, while Frenchmen were slaying Frenchmen and Prussians were looking on, while great guns and small-arms rather than pottery and woollens were in people's minds. In 1851, the year of the first great exhibition, we had looked for the coming of the millennium. The passage of time had brought us the mitrailleuse.

Hungarian Railway Electrification Scheme.

THE Kando system of railway electrification* was conceived by the late Dr. de Kando about seven years ago, and has since given rise to a great deal of experimental work in Hungary. Its advantages are that 50 cycle, single-phase current drawn from the industrial supply is used for operating the locomotives, which are equipped with induction motors, and since the locomotives are fed at a pressure of 16,000 volts, the static transformer sub-stations are spaced at comparatively great distances. The experiments are said to have established the technical soundness of the scheme, and large-scale developments are now being undertaken with a view to testing its commercial value. It is a rather sad reflection that the distinguished engineer who devoted so much study to this system died last January, just before this work was put in hand.

Important contracts for sub-station and locomotive equipment have been placed with the Metropolitan-Vickers Electrical Company in connection with a main line scheme, the contracts covering the whole of the equipment for four 110,000-volt sub-stations, and the greater part of the electrical equipment for thirty-six 2500 H.P. locomotives. The section of railway concerned is in the main Hungarian line towards Vienna, extending from the eastern station of Budapest *viâ* Hegyeshalom to Komárom on the frontier, a distance of 106 kiloms. Single-phase, 1600-volt, 50-cycle current will be taken by the locomotive from an overhead line and used to drive a phase-converter which will deliver three, four or six-phase current to the driving motor at a pressure of about 1000 volts. The sub-stations are to take power from an existing 110,000-volt line, which is fed by the Bánhida power station, each sub-station being connected to two corresponding phase lines of the duplicate three-phase transmission line. The equipment for each sub-station will comprise two 4000 kVA, 110,000/16,000-volt transformers, and 110,000-volt and 16,000-volt switchgear, together with protective gear, testing apparatus and auxiliary equipment. The high-voltage switchgear and transformers will be erected in the open, whilst the 16,000-volt switchgear will be arranged in moulded stone cubicles and installed in a building which will also contain the switchgear control room, the circuit-breakers being remote electrically operated. An interesting feature of the sub-station equipment will be the provision of special equipment, consisting of auxiliary transformers, induction regulators and auxiliary bus-bars, for testing the 16,000-volt line circuit after fault interruptions.

The locomotives are, of course, of special interest. Two designs have been selected, a 2–8–2 passenger locomotive and a 0–12–0 goods locomotive. Both engines will be of the same power, and similar in principle and arrangement, practically the only difference being in the number and diameter of the driving wheels. They will be about 45ft. long and will weigh about 97 tons, with full adhesive weight in the case of the goods locomotives and about 70 tons adhesive weight in the case of the passenger locomotives. The latter are designed for a maximum speed of 63 miles per hour, and the goods engines for 43 miles per hour. Both types will be of rigid frame construction, but provision will be made for a certain amount of side play of the wheels to give flexibility for the long wheel bases in negotiating curves.

The 2500 H.P. polyphase induction motor will have two primary windings on the rotor and a single secondary winding on the stator, and will have four synchronous speeds, the change of speeds being effected by changing the number of poles on the rotor by means of connections on sixteen slip-rings. It will be possible for the rotor to be given 72, 36, 24 or 18 poles, the corresponding synchronous speeds being 83, 166, 250 and 333 r.p.m. respectively. The stator will carry a singly re-entrant lap winding in 48 groups, taps being brought out from between the groups and taken to a liquid starter by means of which starting and resistance control will be effected. The motor will be forced ventilated by means of a fan mounted in the roof of the locomotive.

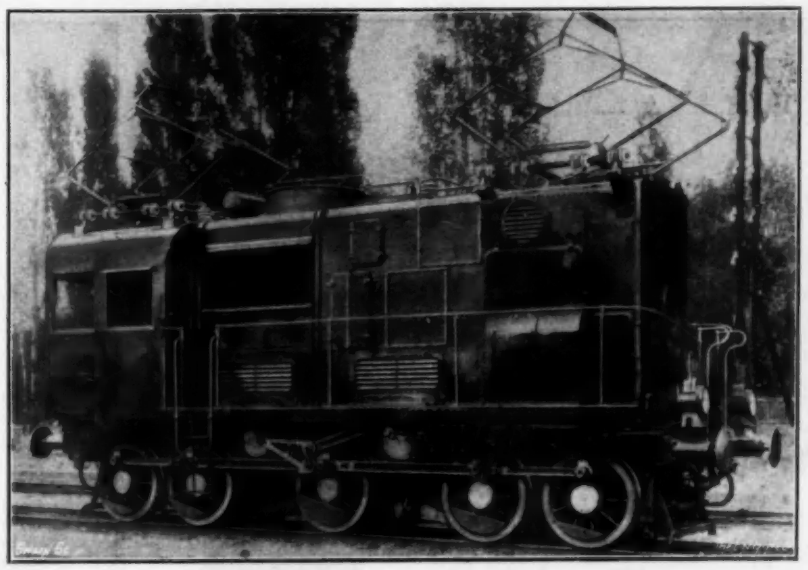
For controlling the connections from the secondary of the phase-converter to the pole-changing leads on the primary windings of the motor, a master-controller will operate in conjunction with a Metropolitan-Vickers switch group, consisting of five triple contact and twenty-three double-contact switches. The switch group will be cam-operated by means of a pneumatic servo-motor.

The liquid controller for providing the variable resistance in the secondary circuit of the motor will be provided with two centrifugal pumps for circulating the liquid through external coolers, and a rising and falling weir will adjust the level of the liquid. The weir will be actuated by means of a compressed air cylinder and will be controlled from a handle on the driver's speed-changing lever, a compressed air-operated load regulator on the master controller giving an automatic adjustment tending to keep the load and tractive effort constant during acceleration.

An experimental 0–10–0 50-cycle, single-phase locomotives is shown in the accompanying illustration.

* See THE ENGINEER, December 5th, 1924.

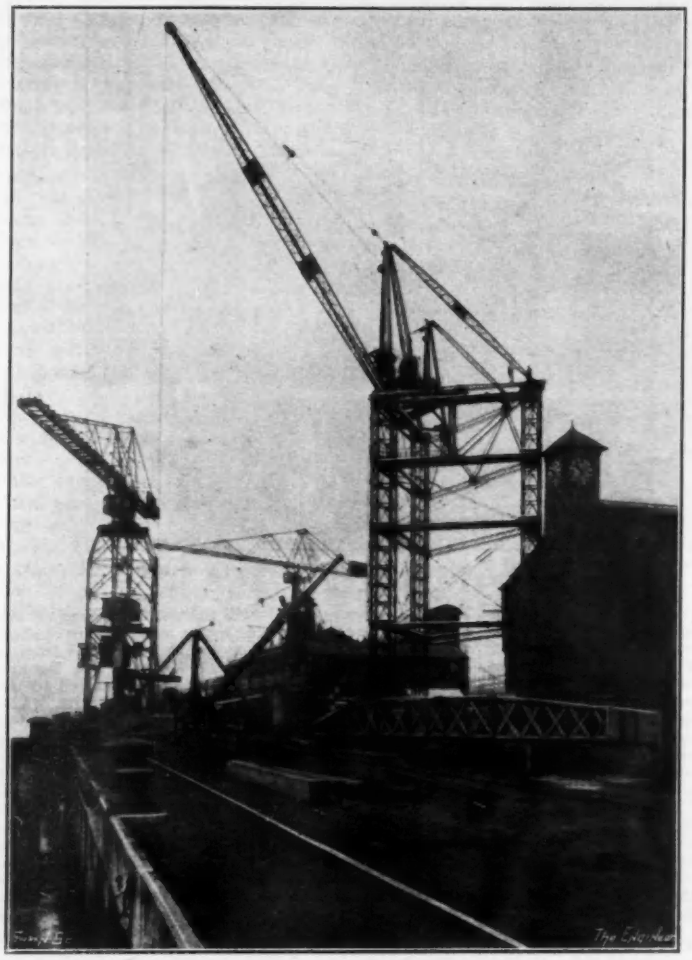
FIFTY-CYCLE SINGLE-PHASE ELECTRIC LOCOMOTIVE



THE report, which has just been issued, of the Council for Scientific and Industrial Research of the Commonwealth of Australia shows that that conntry is taking a serious interest in technological investigation, although the institution is now only four years old. Among other subjects dealt with in the report there may be mentioned the liaison with the Home Fuel Research Board, concerning low-temperature distillation and hydrogenation, the setting up of standards of measurement, and simplification in the number of standard commodities of one class. As an example of the catholic nature of the report the statement that no commercial output has been found for the skins of flying foxes may be mentioned.

STAGES IN THE ERECTION OF A 250-TON ELECTRIC HAMMERHEAD CRANE

SIR WILLIAM ARROL AND CO., LTD., GLASGOW, ENGINEERS



SINKING THE FOUNDATIONS

ERECTION OF THE STEEL TOWER

A 250-Ton Electric Hammerhead Crane.

In a Supplement to this issue and on pages 492 and 493 we publish drawings and illustrations of a large hammerhead crane recently constructed and erected by Sir William Arrol and Co., Ltd., at the Naval Yard of Vickers-Armstrong, Ltd., Walker, Newcastle-on-Tyne. A photograph of the completed crane is reproduced on page 488, from which it will be seen that it consists of a horizontal jib which can revolve on the top of a steel tower. A trolley capable of handling working loads up to 250 tons travels along the cantilever and an auxiliary portal jib crane is also installed for handling smaller loads up to 20 tons.

The foundations for the structure consist of four cylinders, each 18ft. in diameter at the base, which were sunk by the pneumatic process to a solid foundation of freestone rubble 78ft. below the quay level. Erection of the steel tower upon the foundations was begun on September 16th, 1930, and in the photographs reproduced above the stages of the work can be seen. A 20-ton Scotch derrick crane erected upon a steel gabbart staging 100ft. in height was used for these operations. By November 8th the platform girders at the top of the tower had been completed and the roller paths live ring and drum girders were placed in position upon them in readiness for the erection of the jib.

Particular care was taken by the contractors to ensure that the bedding of the roller paths on the platform girders should be perfect, and a special revolving planing machine was used. The platform girders and a short section of the legs was erected in the works, turned and fitted locating bolts being used in all the connections, and the bed of the roller path was accurately machined to level. A photograph illustrates the machine in operation. At the site the machined surfaces of contact of the roller path and the platform girders were coated with thick red lead and bedded.

As soon as the part of the jib directly over the tower had been completed the 20-ton portal crane was installed and used for the erection of the shorter arm and the placing in position of the machinery. At the same time a 10-ton derrick crane was used for the erection of the longer arm and the main trolley. The cantilever jib of the 250-ton crane was kept in balance while the two arms were being built out from the centre. A photograph of the crane nearing completion is reproduced on page 488.

The speeds of the various motions of the main hoist are as follows :—

Hoisting	.. ..	250 tons at 3ft. 6in. per minute, or 100 tons at 9ft. per minute
Racking	.. ..	250 tons at 40ft. per minute
Slewing	.. ..	250 tons at 1 revolution in 10 minutes

The lifting capabilities of the crane are 250 tons at 105ft. radius, 200 tons at 130ft., 150 tons at 150ft., and 100 tons at 184ft. The machinery is placed in a house formed of steel plating at the tail end of the jib, where it assists as a counterbalance.

The load is carried on a trolley supported on eight wheels travelling on four lines of track on the top of the cantilever, and it is lifted on twelve parts of best plough steel wire rope reeved double, each part coiling on a separate barrel. From the barrels the lifting ropes pass round pulleys on the trolley to the snatchblock and thence to the jib nose, where a balancing arrangement is provided to equalise the pull on the two parts. The two barrels, each 7ft. in diameter, are machine grooved on the circumference to take the lifting ropes and they coil sufficient rope in one layer for a total lift of 208ft. The hook of the main trolley may be drawn up to a level 160ft. above the quay or dropped 48ft. below it.

The lifting mechanism is quadruple purchase and the first motion gears run in an oil-tight gear-box. Change of speed is obtained by means of a sliding clutch.

Two systems of brakes are fitted for controlling the load when lowering. One, of the electric solenoid type, is fitted on an extension of the motor spindle and the other is an oil pump brake. The latter is similar to many others used by Sir William Arrol and Co., Ltd., on heavy capacity cranes and the type has proved very satisfactory, giving, as it does, excellent control of heavy loads. It is so interlocked with the gearing that when the crane is lifting the load no resistance is offered to the movement, but as soon as the load takes charge it comes into action automatically. When lowering the load the brake is controlled from the driver's cabin.

The racking gear is in duplicate and is carried on the trolley, and all the rail wheels are driven. The slewing mechanism is placed at the rear of the roller path; it consists of a set of gearing actuating the slewing pinion which gears with the rack. The first reduction gear runs in an oil-tight box and an electric solenoid brake is fitted to the motor spindle. The diameter of the roller path on which the crane revolves is 46ft. 6in.; there are eighty rollers of forged steel in the live ring, each 16in. mean diameter by 16in. long.

It will be seen from the photograph reproduced on page 488 that an auxiliary revolving jib crane has also been installed on the top of the main cantilever for dealing with lighter loads. This travels the full length of the main jib on tracks separate from those upon which the main trolley runs. The speeds of the various motions of the auxiliary crane are as follows :—

Hoisting	.. ..	20 tons at 20ft. per minute 10 tons at 40ft. per minute
Slewing	.. ..	20 tons at 1 revolution per minute
Travelling	.. ..	20 tons at 60ft. per minute

This auxiliary crane can travel a distance of 288ft. along the main cantilever, and it is able to lift 20 tons at 25ft.

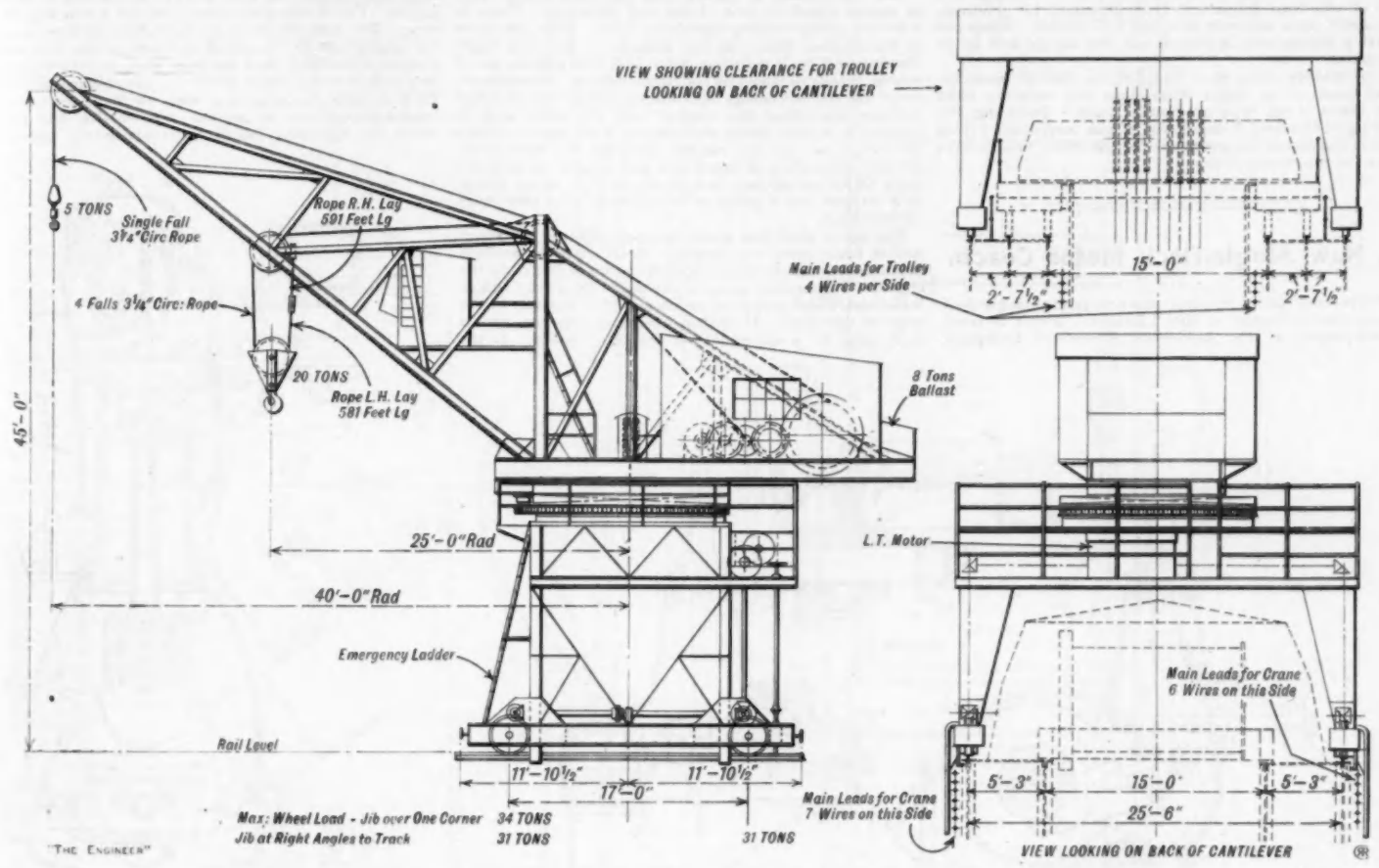
SPECIAL REVOLVING PLANING MACHINE FOR THE ROLLER PATHS

radius and 5 tons at 40ft. radius. Reckoning from the centre of the main crane, these radii become 208ft. and 223ft. respectively. The load is lifted on four parts of steel wire rope, winding two parts on to the barrel. A single fall of non-rotating rope winding on to a separate barrel is used for lifting light loads up to 5 tons, the speeds of hoisting being 78ft. per minute for 5 tons and 156ft. per minute for 2¼ tons. The maximum height to which the 5-ton hook can be lifted above quay level is 227ft. and the corresponding height for the 20-ton hook is 215ft. Both hooks can be dropped 25ft. below quay level. The hoisting gear is quadruple purchase, the first-motion gear running in an oil-tight gear-box. Change of speed is obtained by means of a sliding clutch, and an electric solenoid brake and a foot brake, both worked from the driver's cabin, control the load.

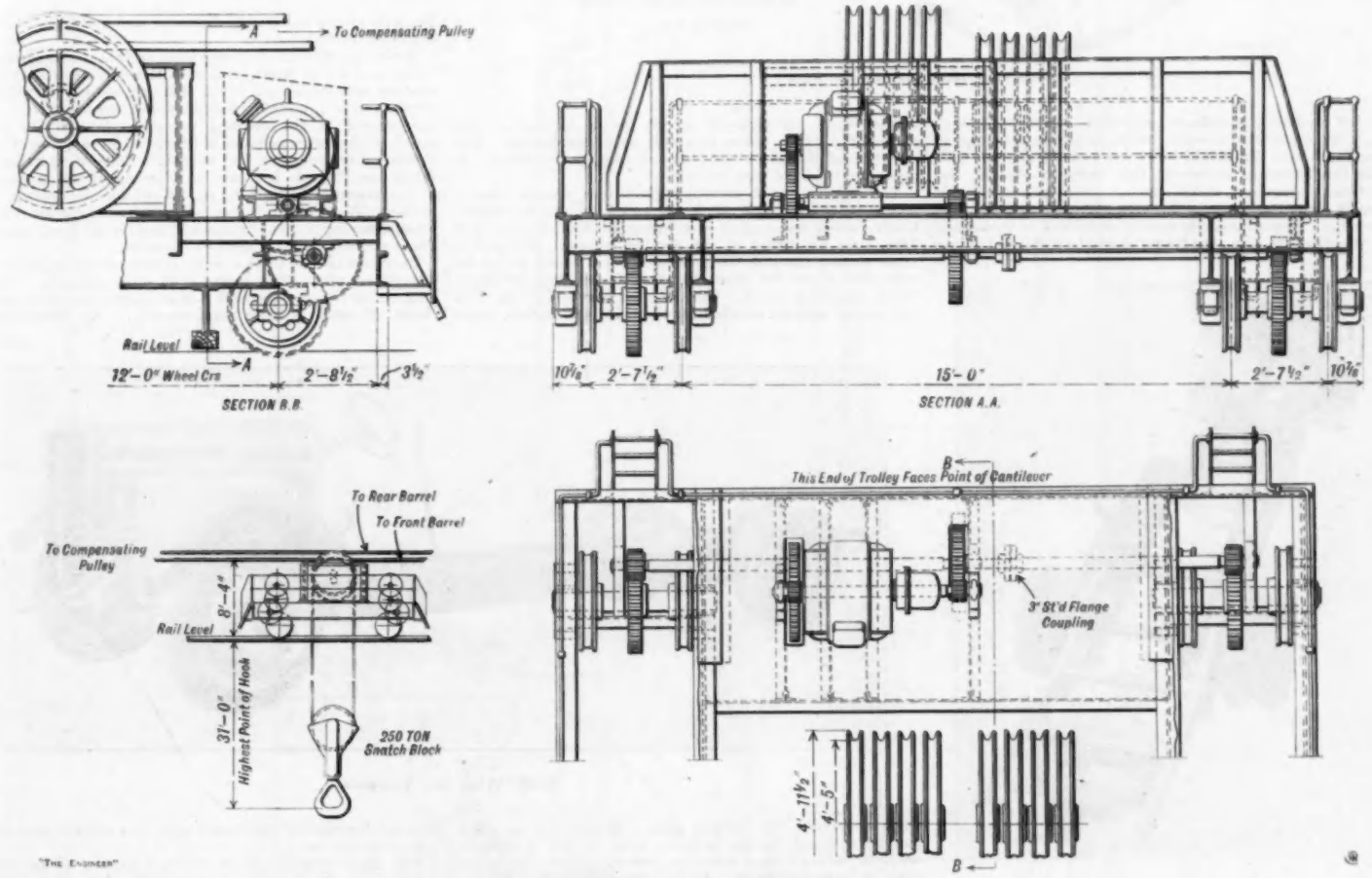
The slewing mechanism is placed at the front, power being transmitted to the rack pinion through worm and spur gearing. A slipping device is incorporated in the worm and worm wheel motion, which is enclosed in an oil-tight box. A foot brake is fitted to this motion. The travelling gear is fitted to the carriage, power being transmitted to the rail wheels, all of which are driven through spur and bevel gearing. An electric solenoid brake operates on the motor extension shaft. It was thought wise to fit special rail grips to this crane, owing to its exposed position.

The auxiliary jib crane is a self-contained unit, having its own driver's cabin and controls. In addition, the slewing gear of the main crane can be operated from the cabin of the auxiliary one.

The main trolley and the auxiliary jib crane are electrically interlocked with one another in such a way that the latter must be within 5ft. of the tail end of the main cantilever, where it acts as ballast, before the main hoist and rack can be operated. When not in use the jib crane is locked in this position. Retardation switches are fitted which operate near the ends of its travel, so that motion is automatically stopped before the crane comes up against the buffers, but the operation of a re-set switch allows it to be continued at a reduced speed. Similarly, limit switches are fitted which cut off the current to the racking motions when the main trolley reaches the limits of its travel. The



DETAILS OF THE AUXILIARY PORTAL JIB CRANE



DETAILS OF THE MAIN TROLLEY

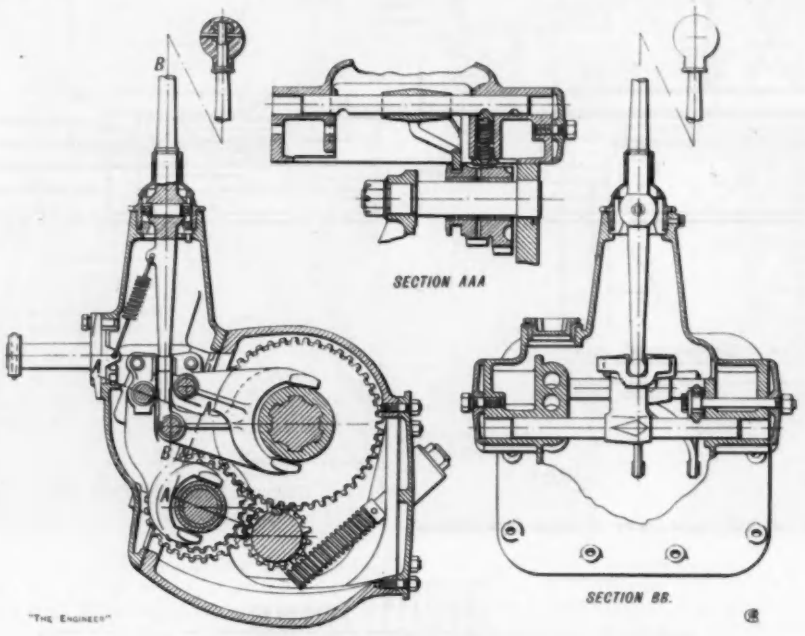
main control cabin is fitted with an electrically operated indicator, which informs the driver as to the position of the trolley and the maximum safe load it can carry in that position. Communication between the driver and those on the quay level is attained by means of loud-speaker telephones.

The motors and control gear were manufactured by the British Thomson-Houston Company, Ltd. The motors are of the dual frequency type arranged for working, primarily, on a 440-volt, 40-cycle, A.C. circuit. When the district change-over is carried out the supply will be at 50 cycles.

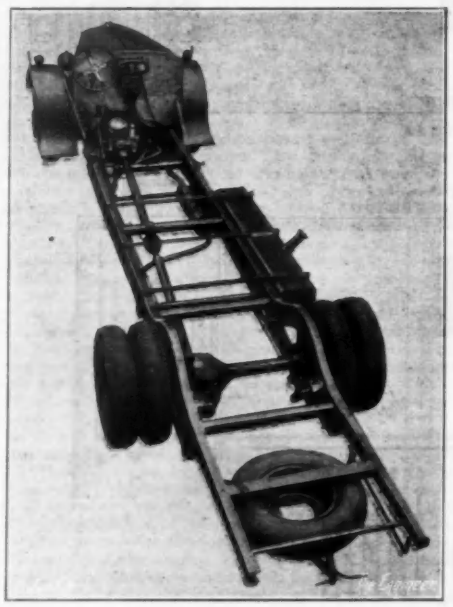
The makers claim that this 250-ton electric hammer-head crane is of larger dimensions and capacity than any crane of its type previously built. Including the sinking of the deep foundations, it was completed within twelve months of the acceptance of the order, twelve days ahead of the contract time.

A New Single-Deck Motor Coach.

We recently had a trial run on a new type of single-deck motor coach, known as the "Ranger," which is being manufactured by the Associated Equipment Company, Ltd., of Southall, Middlesex, especially for service overseas. We reproduce several drawings and engravings of these machines. It should be pointed out, however, that while the drawings represent the standard chassis, the half-tone engravings show one of two special chassis recently sent to Canada for the Montreal Tramways Company. The alterations merely consisted in increasing the wheel base to 19ft., the frame length to 30ft., and fitting a left-hand drive. As a consequence, the side frames have been made slightly thicker than the standard, the road springs strengthened, and 30in. by 9in. low-pressure tires fitted to take the bigger load which will be carried. Otherwise the chassis is of standard design.



CROSS-SECTION OF GEAR-BOX



CHASSIS COMPLETED

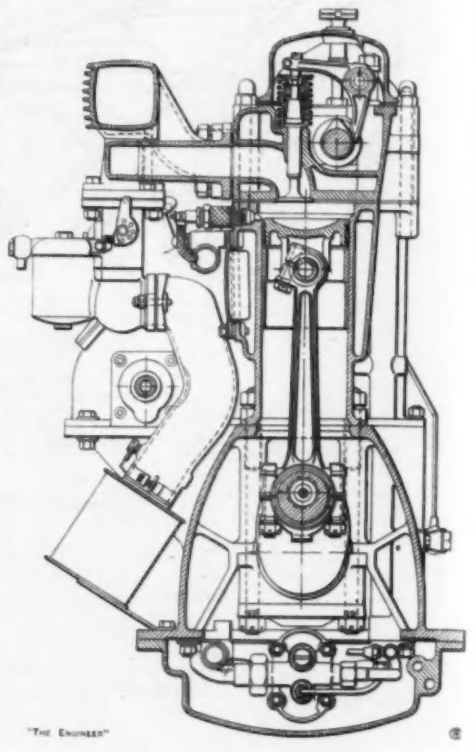
The vehicle is driven by a six-cylinder petrol engine having cylinders 110 mm. in diameter by 130 mm. stroke. It is rated at 45 horse-power, but will give 58 B.H.P. economically at 1000 r.p.m., and can be speeded up to 2500 r.p.m. when the output is 110 B.H.P. The maximum torque is produced at from 1000 to 1200 r.p.m.

As will be seen from the cross section which we give, the engine has overhead valves, which are operated by an overhead cam shaft, in the drive of which the radiator fan spindle acts as a countershaft in the following manner:—The fan spindle is driven from the main crank shaft at engine speed by twin chains and sprockets. There is a jockey pulley to keep the chains taut. Then the drive is transmitted from the fan spindle to the cam shaft through a 2 to 1 reducing gear. All this gearing is, of course, totally enclosed by the engine casing. The arrangement has the advantage that the cam shaft can be lifted without disturbing the chains. All the valve gear is covered by a light casing and the cam shaft runs in a deep oil trough, so that the various parts are well lubricated. Forced lubrication is employed and ranges in pressure from 80 lb. per square inch down to 5 lb. when idling. It is claimed that a gallon of oil is sufficient for 1000 miles of travelling.

The crank shaft has seven bearings, 2¾in. in diameter, and is made from one forging. Each shaft is carefully balanced by the dynamic method before it is put in the engine. The cooling water is circulated by a very simple little centrifugal pump, of which a section is given in our page of drawings. It has an overhung impeller, and is kept tight by a spring-loaded graphite washer. If the washer wears the impeller merely moves forward in the casing, for which there is ample accommodation. The clutch is of the plate type, and is 16in. in diameter. It takes up the drive very sweetly.

The change speed gear-box gives four speeds and a reverse of 11·9, 19·3, 32·6, 52, and 9·75 m.p.h. respectively, when the engine is running at 2500 r.p.m., and 38in. tires are fitted to the driving wheels. We give a cross section through the gear-box, from which it will be seen that there are three selectors for sliding the gears when changing speed. One selector serves for the first and second speeds, another for the third and fourth, while the third works the reverse gear. Either one of these can be engaged by the selector lever, which is coupled with the driver's hand lever, by passing through the usual style of gate quadrant. As an added protection for the reverse gear, however, there is a projection on the bottom of the hand lever, which, by engaging with a fence, prevents it being moved into reverse until it has been lifted over the fence. Although the teeth of the gear wheels are unusually wide, the gear-box is remarkably compact, with the result that the shafts are short and stiff. A magnetic device, which can be seen in the drawing as what appears to be a square threaded screw, is provided to entrap any steel particles which may find their way into the oil. On being removed from the casing the magnet inside the screw is stripped out and the scrap is then easily washed off.

The propeller shaft is connected with the gear-box shaft through a Spicer flexible coupling, and, as will be seen from the general arrangement drawing, lies at an angle to the main framing, so that the differential gearing comes close up to the near side. In this way it can be accommodated in a dome in the floor under one of the seats, and enables the floor level to be lowered by several inches. The differential drive is of the worm and wheel type. The rear axle is of the semi-floating type, so that the wheels can be drawn off the ends of the axle shafts without disturbing their bearings when it becomes necessary to relieve the brake drums—a valuable feature where Timken roller bearings are used, as they require very careful adjustment to get the best results, and should never be disturbed unless it is absolutely necessary.

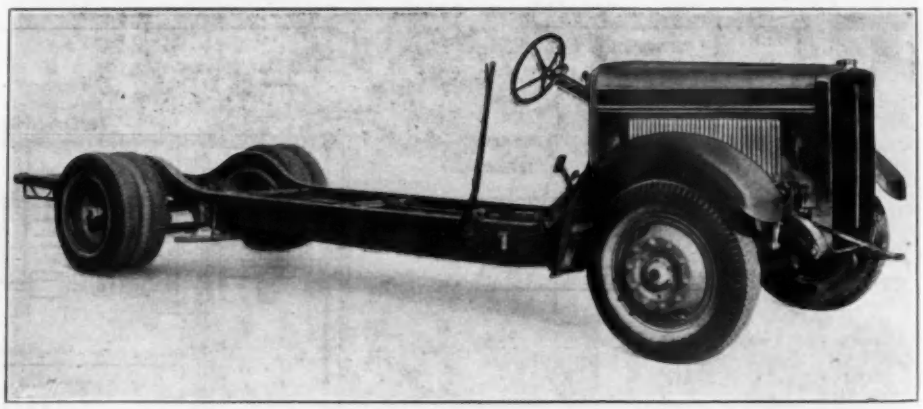


CROSS-SECTION OF ENGINE

The axle shafts are 3in. in diameter and are made of 100-ton steel.

Brakes are fitted on both the front and the driving wheels. There is a set of hand brakes on the driving wheels and another set, back and front, working on the Dewandre vacuum servo principle, in which the driver provides about one-quarter of the braking pressure through the foot pedal, while the remainder is furnished by a cylinder and piston connected with the induction pipe of the engine. When the throttle is closed to slow down the engine, a strong vacuum is produced in the cylinder to operate the brakes. There are only two adjusting nuts for all twelve brakes, one for the foot brakes and one for the hand system. These adjustments are easily accessible.

In connection with the brake system we learned a very interesting fact. The brake rods are, naturally, rather long on such a chassis, and it was found that they sometimes vibrated a little unpleasantly. By substituting thin steel strips for the round rods, the trouble was completely overcome.



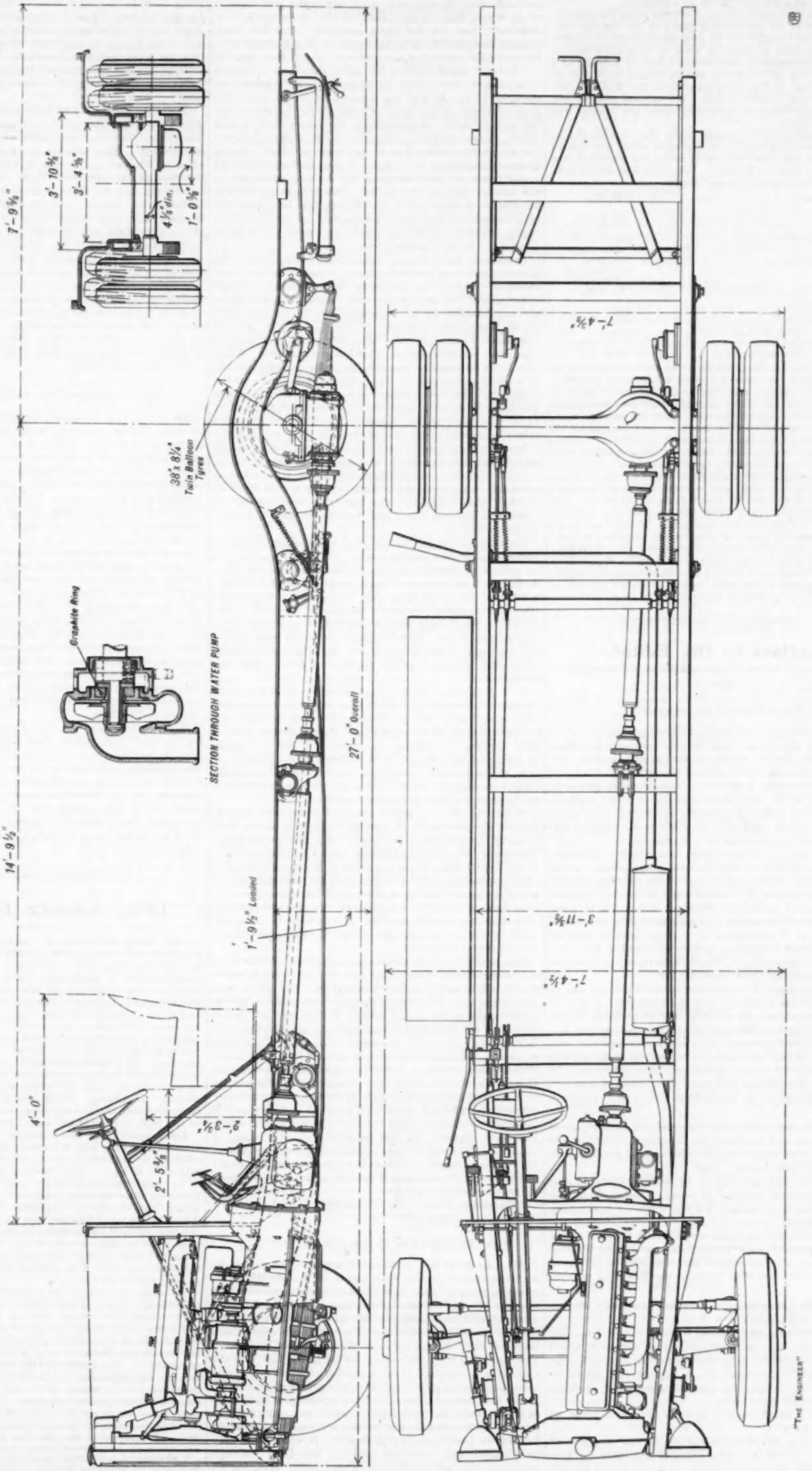
SIDE VIEW OF CHASSIS

The main frames are of channel section nickel steel, and have a normal section of 11in. by 3in., but are naturally tapered towards the ends. They are cranked over both axles, and are braced together by large tubular members, which have solid forged flanges and are riveted in place. The height of the frame above the ground is 1ft. 9¼in. The springs are practically straight when loaded so that they can hardly be called semi-elliptic, although they are of that general type. The standard lengths are 4ft. 2in. front and 5ft. 2in. rear.

The steering gear is of the maker's nut and worm type, and allows the front wheels to be locked over to an angle

45-58 H.P. SINGLE-DECK MOTOR COACH CHASSIS

THE ASSOCIATED EQUIPMENT COMPANY, LTD., SOUTHALL, MIDDLESEX, ENGINEERS



of 45 deg. The linkage is made of solid forgings, so that there are no separate end pieces to work loose.

There is an elaborate system of copper pipes for conveying lubricant to all the moving parts of the chassis, and their ends are brought up to central positions on either side of the vehicle, so that the work of lubrication can be done very conveniently and without fear of missing any points. At all places where grease might work out of bearings along shafts, spring-gartered hat leathers are arranged at the critical points. We noticed that at the spots where the coaches habitually stand the ground was remarkably clean.

It is unnecessary to enlarge upon the coachwork, as that is, naturally, a matter for the taste of the purchaser; but we must say that the one in which we travelled was very pleasant and comfortable. The principal dimensions of the standard chassis are as follows:—

Wheel base	17ft. 0in.
Track:	
Front	6ft. 3 1/8in.
Rear	5ft. 10 5/8in.
Overall length	25ft. 9in., or 26ft. 11 1/4in.
Overall width	7ft. 5 1/2in.
Body space	21ft. 6 3/4in., or 22ft. 6 1/4in.
Height of frame—loaded	1ft. 9 1/2in.
Turning circle:	
Right-hand	60ft.
Left-hand	80ft.
Clearance under rear axle	7 1/4in.
Chassis weight	3 tons 3 cwt.
Passenger accommodation	26–28

We took one of these coaches out for a short run in Middlesex with the idea of testing its running qualities. The first test was over a very rough length of concrete road. Although the load comprised only two passengers and the driver, the riding was quite reasonably comfortable at from 25 to 30 miles per hour, and it would no doubt have been better still with a full load. Then we made for Harrow Hill, which, as some readers may know, is not easy to climb, as it has several turns and, we believe, a maximum gradient of 1 in 14. The hill was approached in top gear, and we had the speed reduced on the side of the hill to about 5 miles per hour. The engine picked up again when the throttle was opened, and the top of the hill was reached at 30 miles per hour without changing gear. Again, traffic required a dead stop, and within a few hundred yards we were travelling at over 50 miles per hour, but this manœuvre required, of course, gear changing. Throughout these trials the engine did not complain in the least, and after a good stretch at speed, there was no sign of the radiator boiling.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

THE AIRSHIP EXPERIMENT.

Sir,—Now that the admirable and comprehensive report of Sir John Simon on the "R 101" disaster has been published, the time is opportune for the review of the airship experiment, though it did not need this appalling, but entirely preventable, accident to cause thinking people to be doubtful of the wisdom of continuing State expenditure in a field where prolonged, intelligent and costly effort has brought forth so little which is encouraging and so much which is very definitely the reverse.

In 1924, largely, if not wholly, as a result of intensive propaganda on the part of some airship enthusiasts, whose discretion and experience were outrun by their almost incredible optimism, the Government of the day adopted a programme of airship development which can be most fairly put before the reader by a quotation from the official description of it appearing in a memorandum entitled "The Approach Towards a System of Imperial Air Communication," presented by the then Secretary of State for Air to the Imperial Conference of 1926:—

"The experimental programme adopted in 1924 was to extend over three years and to cost £1,350,000. It is now, however, estimated that the cost will be between 1¼ and 1¾ million pounds. The purpose of the programme was to make a real advance in airship development and thoroughly to test the capacity of modern rigid airships as a standard by means of long-distance transport. In general the programme consisted of a period of research and investigation in preparation for two practical operations:—

"(1) The construction of two airships of such improved speed, range and load-carrying capacity as would enable them to make long voyages overseas with a substantial margin of lifting power; and

"(2) The carrying out of successful flights to and from an overseas terminal, in order to demonstrate that the airships were suitable for the work for which they were designed."

The specification for these ships which appears in the contract between the Air Ministry and the Airship Guarantee Company, who undertook the construction of one of the two vessels, "R 100," contains the following requirements:—

"(1) The gas capacity is to be not less than 5,000,000 cubic feet when full.

"(2) The ship must attain a speed of not less than 70 miles per hour as measured by an approved speed indicator at 5000ft. under standard conditions and must be capable of maintaining a normal full speed of 90 per cent. of this rate, say, 63 miles per hour for a period of forty-eight hours.

"(3) The total fixed weights of the airship not to exceed 90 tons."

Turning now to an examination of the measure of success with which the two experimental airships met these demands, while it is pointed out in the Simon Report that "R 101" never carried out a full-speed trial, it is probable that, as originally constructed she was capable of satisfying this requirement; on the other hand, it is definitely clear, on the same authority, that her fixed weights exceeded the specified figure by 23·6 tons and that her useful lift, instead of being 60 tons, was, in fact, only 35.

"R 100," which, unlike her sister ship, was subjected to a comprehensive series of trials, attained a maximum speed of 82 m.p.h. and has a useful lift of 54 tons; so, judged merely on the basis of contract requirements, she has proved herself immeasurably the better craft, a fact which, in fairness to her designer, B. N. Wallis, deserves the recognition which has as yet been withheld, mainly because apologists on behalf of the Government-built vessel have obscured the issue by drawing attention to the heavier engines of "R 101." Now, however, on the unquestioned authority of the Report, this half-truth has been reduced to its correct dimensions, for the respective engine weights, including auxiliaries, were:—"R 101," 17 tons; "R 100," under 9 tons.

In order to determine the value of the airship as a means of transport it is probably fairer, certainly to its advocates, if "R 100" is chosen as the vehicle for detailed examination. In accordance with contract requirements, she was designed for 100 passengers and, on the authority of Sir Dennistoun Burney, a director of the Airship Guarantee Company, cost £440,000; thus, per unit of passenger accommodation, £4400 was expended. While this is an impressive amount, its millstone-like quality grows with examination. The corresponding figure for the "Argosy," the three-engined plane which has done and continues to do such good work for Imperial Airways, is £1250; but this striking disparity is still further increased if Sir Dennistoun's view that the true capacity of "R 100" is but fifty passengers is adopted, and grows yet further if, abandoning an expression of opinion in favour of arithmetical similarity, it is assumed that the same ratio of passenger capacity to ship volume applies to "R 100" as to the "Graf Zeppelin," for then the total number of passengers becomes thirty and the cost per unit of accommodation £14,700.

Turning now from capital cost, some examination of operational expense can be made; but since experience is at present so limited, this can be by no means complete. As designed, the maximum power per passenger in "R 100" is 42 horse-power, while in the "Argosy" it is 67; however, this apparent economic advantage completely disappears if the Burney figure of capacity is accepted, while on the basis of the "Graf Zeppelin" ratio the horse-power per passenger of the airship is over twice that of the aeroplane and at equal speeds approaches three times the latter figure.

It is not necessary to draw attention to the cost of hydrogen—of which the wastage in our ships is considerably over 7 cubic feet per horse-power hour of flight—or to the rapid rate of deterioration of their immense areas of light textiles, amounting in all in "R 100" to over 14 acres, for such figures as have already been given show that at the present state of its development the airship, judged as a means of civil transport, must be vastly more costly than the heavier-than-air machine.

While the above argument at least gives some indication of the economics of airship flight in contrast with those of the aeroplane, to complete the picture the latter requires to be put upon a concrete basis. On the authority of Sir Eric Geddes, there are some 1200 commercial aeroplanes operating in the world to-day, the vast majority of which would be making a substantial loss were it not for some form of subsidy; consequently it is most abundantly clear that the airship requires, and in view of its necessarily slow development, will continue to require substantial governmental assistance.

The promises of the airship propagandists of 1924 have not been fulfilled, though they have had six years and over £2,500,000 to assist in their redemption. For over a year aeroplanes have been maintaining a very reliable service between this country and India. Within another twelve months it will be clear whether Australia and the Cape can be similarly connected. It remains in doubt, and may long so remain, whether any form of aircraft can carry out a Transatlantic service; but even should it be proved that this field alone lies within the competence of the airship, it is more than doubtful, quite apart from economic considerations, whether there will ever be a sufficiency of passengers willing to trust their lives to a machine whose buoyancy depends on the reliability of vast areas of textile material and whose combustibility—unless inflated with helium, which, as far as is at present known, is not available in sufficient quantities within the Empire—must be an ever-present danger.

P. L. Teed.

"Hayesden House," Nr. Tonbridge.
April 27th.

THE ELECTRIFICATION OF RAILWAYS.

Sir,—In your last issue there appeared an article by a correspondent on the Weir report on the electrification of our railways. I consider it one of the best reports which appeared in the technical Press last week-end, and while agreeing with your correspondent on the whole, I think his statement on the possibility of breakdowns might have been left out. In the old days, the chances of breakdown were less than they are to-day, owing to the fact that the current was supplied from a number of small generating stations, so that a total breakdown was practically nil. With the introduction of the A.C. and the tendency to build large super stations, and also larger outputs per unit, both as regards hydro-electric and steam stations, the risks of breakdown have become greater now. A whole town may be plunged into darkness and all the local railways paralysed through the failure of one unit. But, for all that, no one, for economic reasons, would ever think of going back to the old system of small units. The introduction of long-distance transmission has brought with it the use of high-tension distribution and the use of the A.C. with its many problems which are not all solved. But we have sufficient knowledge of same to carry on and apply same with success to the electrification of our railways, and any difficulties which may arise will be overcome.

One of the biggest breakdowns which has occurred within recent years was that which took place in Chicago in 1919. There were three stations joined together, totalling about 500,000 kW. Two systems are used, one of 25 and the other of 60 cycles. It was on the 25-cycle system that the breakdown occurred. There was a short circuit on one of the generators in Fish-street station, which was immediately cleared. An unstable condition resulted through same and lasted about 18 minutes. The cause of the instability was through not having reactors fitted in the station where the trouble occurred. Reactors were fitted in all the other stations, but on account of cost of same had been omitted in the Fish-street station. I simply mention the above to show that while your correspondent is right in pointing out the possible objections to the use of electricity for supplying our railways, there is no reason why we should be afraid. We should go ahead with the scheme of electrification, and though, no doubt, difficulties will arise, they will soon be got over.

Liverpool, April 28th. Charles Rettie.

THE "QUEEN OF SCOTS" TRAIN.

Sir,—In reply to your correspondent, the "Queen of Scots" is a very light train reserved for passengers paying high special fares, and as such ought to take a place amongst the really good trains of the world—such as the "Empire State Express," the "Sud Express," or the Montreal-Toronto trains—and ought to run between London and Edinburgh in 7 hours or less. It must be remembered that as long ago as 1896 the timing for passengers paying no more than 1d. per mile was only 7 hours 25 minutes.

As to the performance of the French train, I cannot tell your correspondent what further delays we met with during the night, or when the lost time was regained, for I was asleep. I have not a copy of the French timetable, and the continental Bradshaw unfortunately does not give the running of this train in full. It does, however, show the last stage of the journey—Amiens-Calais (not Havre, as your correspondent seems to imagine), 104½ miles in 113 minutes. As this includes 7 miles of climbing at 1 in 125, and slow running through Calais out to the boat station, an English driver with about 500 tons behind the tender might not think it left him much in hand for picking up lost time.

However this may be, the French compound engines for the last thirty years have been ready for all emergencies, and it is time that we should cease making ourselves ridiculous by writing to the Press whenever a light British train does something more than the timetable requires. The L. and N.E. Company refuses to supply fast schedules on the ground that the public does not care for speed. Why, then, this eagerness to inform the public when one of its trains makes a fast run?

London, April 27th. W. B. Thompson.

Long Distance Telephony.*

The first international telephone circuit between England and France was opened as long ago as 1891, but growth was very slow until after the war, when developments in apparatus, particularly the valve telephone repeater, opened up new possibilities and enabled great strides to be made. The first circuits had no repeaters and were composed of very heavy overhead wires, with sea-cable links where necessary. The expense of these lines was so great that only a few circuits could be provided, and delays of several hours in obtaining a connection were common. At present there are 31 circuits between London and Paris, all underground cables, equipped with repeaters at intervals of some 50 miles, and quite unaffected by weather conditions. With several hundred calls a day being handled, the average delay in obtaining a connection at the busiest time of the day is under 15 minutes.

Quite apart from the technical problems of telephone transmission over long distances, there are many problems relating to the handling of the traffic, which are considerable if the routes covered are under the control of a single administration, and may be enormously increased where the route passes through different countries under the control of separate administrations. This difficulty of co-ordination has been effectively met by the formation of a committee of experts from all countries, who meet to discuss and advise on all questions, both technical and commercial, relating to the international telephone service. This committee is usually abbreviated to, and known as, the C.C.I.

Although the use of the repeater has made telephony possible over much greater distances than would otherwise be the case, it is found that, as the range is extended and more repeaters are used, troubles which pass unnoticed on short lines accumulate and place an effective limit on the maximum distance over which good speech can be transmitted. Ten years ago this limit was about 500 miles, but the developments which have since taken place have increased this to about 3000 miles, and in some circumstances to even greater distances. Successful transmission over these distances is only achieved by the greatest possible precision in the performance of every link in the chain of equipment, so that the whole circuit functions

* Abstract of paper read before the Students' Section of the Institution of Electrical Engineers by L. S. Crutch.

as a complete unit and not as a collection of individual pieces of apparatus.

The transmission of telegraphic signals over long submarine cables is well known, but at the present time the transmission of speech over similar lengths is, if not impossible, a doubtful economic proposition. It is here that the radio-telephone link, coupled to the land-line circuits, makes world-wide telephony an established thing. The success of the trans-Atlantic radio link between Rugby and New York—opened in 1927—first drew attention to the possibilities of this scheme, and since then similar links have been established between many other parts of the world.

Having discussed the growth of this service, it is interesting to see what the requirements are for the electrical circuits and apparatus used for it. The start and finish of any link is always the subscriber's instrument, and new developments have resulted in the production of an instrument which is vastly superior, both in convenience to the user and in electrical performance, to older types. The intervening circuit will be considered under the following headings :—(*a*) Overhead lines ; (*b*) loading and cables ; (*c*) repeaters ; (*d*) repeated circuits.

The present-day reliability of long-distance telephony is largely due to the use of underground cables in place of overhead lines. Whilst overhead lines provide a good and cheap method of transmission, if only a comparatively few circuits are involved, their construction becomes complicated and unsightly when a great many circuits are required. Furthermore, they depend too much on weather conditions for their performance. A heavy fall of snow or severe gales may dislocate a complete service for some days, with consequent serious loss of revenue, inconvenience to business generally, and heavy repairing costs. The variation of line constants with changing weather conditions creates peculiar problems in connection with the use of repeaters on such lines, and tends to make the system rather variable in performance. The use of repeaters can be avoided for moderate distances by the provision of very heavy-gauge conductors, but the expense of these lines increases very rapidly as the gauge of conductors is increased.

Loading is the name given to the addition of inductance to a line or cable in order to improve its transmission characteristics. It was first suggested by Heaviside, as the result of theoretical investigations, that the addition of some inductance to the line would improve its efficiency, but it was not until the practical applications were worked out by Pupin that loading was tried commercially. Inductance may be added by winding fine iron wire directly over the copper conductor or by inserting coils at suitable points in the cable. The former method, termed continuous loading, is ideal as regards uniformity of loading, but is very expensive and is mainly confined to submarine cables, where the addition of coils is difficult. The theoretically ideal loading condition is never attempted in practice, as good results are obtainable at much less cost with a loading of some 10 per cent. of the theoretical value.

The technique of thermionic valves and amplifiers is too well known to need explanation. A simplex repeater —more usually called a four-wire repeater—is similar in all its essentials details to a low-frequency amplifier used for broadcasting. Where conversation is carried on over two wires the repeater has to amplify speech in both directions over the line, without mutual interference or instability. This requirement is met by the use of a differential transformer associated with the line on either side of the repeater, in conjunction with networks to balance the lines. The successful operation of a two-wire repeater depends upon the accurate matching of the line with its balancing network, lack of which causes continuous oscillation or howling of the repeater. This balance is only obtained by uniformity of line and loading characteristics. It is not usual to employ two-wire repeaters on very long circuits, and for distances above about 400 miles the four-wire system of working is usually employed. The maintenance of termination balance is important in order to avoid echoes which interfere with satisfactory reception of speech. It is difficult to eliminate these echoes, and devices termed echo suppressors are generally employed. There are two types in general use, each shunting a small portion of the voice energy, then amplifying and rectifying it. The unidirectional energy thus obtained is used in one type to operate a sensitive relay which short-circuits the "return" line when speech is passing over the "go" line. In the second type the energy is used to paralyse one of the repeaters in the return wire so that the line is effectively open-circuited from the transmission point of view. It will be understood that both devices are operated by the voice currents without any other form of control.

It has been previously stated that the successful operation of a repeater system depends upon the uniformity of the line characteristics. This is ensured by the use of uniform materials in manufacture and by expert installation. Loading coils must be correctly situated and the line capacitance must have as nearly as possible the same value per unit length all along the line. Measurements of capacitance deviation in individual pairs of a cable length enable jointing to be made in such a way that this condition is fulfilled. Secrecy is all-important in telephone work and over-hearing between circuits must be eliminated as far as possible. Cross-talk is more serious on long loaded circuits than on shorter circuits and is principally due to differences in the capacitances between the wires of the different circuits formed by a quad. Uniformity of manufacture and measurement during installation enable the jointing to be carried out in such a way that the net unbalance over a whole length is quite small. Noise due to interference from near-by power circuits or from telegraph apparatus on the circuit has also to be eliminated. This is achieved partly by making the repeaters insensitive to the frequencies of which these noises consist and partly by methods of shielding and balancing.

The circuit between London and Madrid is quite complex in its make-up, as it consists of a coil-loaded cable between London and Canterbury, continuously loaded cable across the English Channel to La Panne, thence by cable to Paris and then originally by carrier-current telephony over open wire lines to Madrid. This last section has now been modified by the opening of a cable between Paris and Bordeaux, the remainder of the route being by overhead lines.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(*From our own Correspondent.*)

Market Situation.

BUSINESS fails to develop substantially in the Birmingham iron and steel market, and the general trading situation throughout the Midlands and Staffordshire remains unsatisfactory. Confidence in the future is still lacking and reports from industrialists in the various branches of heavy engineering and manufacture are far from reassuring. District works for the most part are operating at less than half capacity, and in numerous instances skeleton staffs are able to turn out all the goods required in two or three working days. Not only so, but additional hands are being dispensed with almost every week. Consumptive demand is at a very low ebb, and, except in the case of one or two favourably placed trades, such as automobile manufacture and electrical engineering, there is no immediate prospect of demand growing. Iron and steel is called for in small tonnages sufficient to meet the needs of the week, and bulk buying and contracting forward are almost unheard of these days. Attendance on 'Change in Birmingham at the weekly meeting of the iron trade was poor and business was conspicuous by its absence.

Staffordshire Bar Iron.

The slight improvement in the Staffordshire finished iron trade noted last week has been maintained, and additional orders have this week come to hand. It must not be assumed that anything in the nature of a trade revival in this industry is indicated by these facts. There is not sufficient evidence to justify such an assertion, or even to encourage such a hope. The movement, however, is certainly in the right direction, and, if sustained, will, in time, enable Staffordshire ironmasters to report progress. They have had a very trying time of late, and the enhanced demand, small as it is, is very welcome. It is chiefly in the strip department that this improvement has taken place, and it is worthy of note that this branch of the iron trade has been fairly steadily engaged throughout. This fact has enabled producers to keep up their selling prices at the reasonably high level of £10 17s. 6d. per ton. They have been up to £11 and, indeed, some firms are reported to be asking this price at date, but the market level for some months past has been in the region of the lower figure. Marked bar makers are also faring better, and while the mills are not so well employed as those producing strip, they are fairly active. Values have been reduced by 10s. per ton, bringing the selling figure to £12 at makers' works, and this reduction may account to some extent for the better demand experienced during the past week. This high class iron is always in certain request for exacting engineering requirements, but production has been and still is, much below capacity. In the Crown bar branch some makers are again cutting prices in an endeavour to secure new business. Though some firms adhere to the £10 level, others are reported to be offering supplies at £9 10s. It is claimed that £9 5s. would be accepted in some quarters as a means of keeping mills in operation. There is so little business about that works which maintain a firm hold on prices assert that they stand to loose nothing as the result of competitors' price cutting tactics. In the nut and bolt bar department, there is practically no business passing. Consuming industries are poorly employed, and on account of the vast difference in price, when they require material, they almost invariably buy foreign. Bars of this class made in Staffordshire are quoted at £8 12s. 6d. to £8 15s. per ton. The recent lowering of minimum selling rates by half-a-crown per ton has, apparently, had no effect in stirring up business.

Raw Iron.

The raw iron market is cheerless. Consumptive demand is no better and inquiries amongst consumers do not elicit encouraging statements as to future requirements. The foundries and forges have not sufficient employment to absorb the output of Midland brands of pig iron, but the anxiety of over-stocking does not, fortunately, extend beyond a few Northamptonshire furnaces. Derbyshire furnaces, with their pipe connections, are better able to find outlets for their production. Furnacemen and merchants in this district are only receiving small specifications for foundry material, and consumers do not come into the market until they have used up every ounce of iron. Prices stand at £3 7s. 6d. for Northamptonshire No. 3 and £3 11s. for Derbyshire and North Staffordshire, delivered Black Country stations. It is this week asserted that the importation of foreign pig iron into the Midlands has not entirely stopped. If this statement is correct, then it is also true that it is confined to very small consignments to foundries whose turnover is too inconsiderable to bring it within the terms of the rebate offer. There seems to be little probability of any change in selling rates of Midland pig iron in the immediate future, but users continue to voice complaints regarding what they claim to be an "excessively high standard" of values.

Steel.

Midland steel works are very short of specifications, and short time is necessary, while the small quantities ordered, covering a variety of sizes, necessitate frequent roll changing. Steelmasters are complaining very much that orders are so small and extend over such a variety of patterns and sizes that an enormous amount of time is taken up in changing the rolls in the mills. It was recently stated that the rolling programmes at some British steel mills range over a hundred or more different specifications in a week. In the course of last year the steel industry was asked to work to 250 different specifications. In many of them the variations were insignificant and non-essential. In this connection it is some satisfaction to know that a committee is now at work under the auspices of the British Engineering Standards Association on the task of co-ordinating and simplifying these specifications. The call for structural steel at date is poor and values are unchanged. Quotations are in accordance with the basis laid down by the Steel Association. Demand for special steels for the automobile industry continues disappointing and below normal for the season of the year. Those branches of the industry which make the largest use of steel are the least active. Small sizes of steel and semi-finished material continue in poor demand, and prices are weak, owing to keen competition. They are not materially changed on the week, however. Continental quotations for semis are reasonably firm. Sellers are doing little business in this area. Demand is so quiet for imported small bars and finished material generally that it is difficult to say what sellers would accept rather than miss an order.

Galvanised Sheets.

In the galvanised sheet trade prices are unchanged at £11 per ton f.o.b. for 24-gauge. A few more orders are coming in from overseas markets, and although the tonnage is not large, the position at local mills is becoming less desperate.

Cast Iron Production Experiment.

A demonstration which attracted considerable interest in Midland industrial circles took place on Thursday of last week at the works of Mason and Burns, Ltd., Pleck-road, Walsall. New plant which has been installed for the production of cast iron and for which the claim is made that it is likely to revolutionise the ironfoundry industry, was demonstrated. The new plant, which was successfully operated, comprises a rotary melting furnace and is capable of a very big output. The idea was evolved in Germany, and the Walsall installation is said to be the second in England. The object is to melt iron by means of powdered coal. The coal is handled automatically, being placed in a bin or bunker, from which it passes into an air current in which it is dried by hot air drawn from a recuperator. Afterwards, it passes into a mill, in which it is converted into coal dust, and is then blown by the air current direct into the furnace. The furnace can be used, if required, for the production of steel, and experiments have been carried out with it for the refining of copper. The claim is made that the furnace will produce a high-test cast iron from scrap metal and that waste is eliminated. Particular instances given of the advantages from the point of view of physical properties are that grey iron made by this process has a tensile strength of 25 tons per square inch and malleable iron an elongation of 20 per cent. A point of interest locally is that, whereas coke from Sheffield and other distant places is used in the old type of furnace, the new method will permit of Cannock Chase coal being used.

Fewer Unemployed.

Unemployment in the Midlands area has taken a turn for the better. The latest returns give the number of workless in the area as 240,870 wholly unemployed, 118,825 temporarily stopped, and 558 normally in casual employment, making a total of 360,253. This is 12,459 fewer than in the week before, and 121,134 more than in the corresponding return of the previous year. The total comprises 244,526 men, 8302 boys, 99,242 women, and 8183 girls. How the position stands in the large towns in the Midlands may be gauged by the present figures and those of a week ago. In Birmingham there are now 65,243 workless, compared with 67,009 a week previously. At Stoke-on-Trent the respective figures are 32,725 and 33,993 ; Wolverhampton, 13,507 and 14,237 ; Coventry, 12,701 and 12,948 ; Leicester, 14,990 and 15,318 ; Nottingham, 14,391 and 15,017 ; Derby, 10,527 and 10,532 ; Cradley Heath, 9003 and 9621 ; Smethwick, 6836 and 7309 ; West Bromwich, 6062 and 6151.

LANCASHIRE.

(*From our own Correspondents.*)

MANCHESTER.

Attracting New Industries.

CHARGED with the dual mission of attracting new industries to the county and of assisting existing industries to further development, the Lancashire Industrial Development Council has now been formally inaugurated. The Liverpool Organisation, a more parochial body with similar objects in view, has been actively in operation for several years, and has met with some measure of success. The Manchester Development Committee has quite recently been founded, and there are hopes that its work will meet with reward. Both these bodies are complementary to the Lancashire Industrial Development Council, which is representative of official and industrial interests throughout the county. Lancashire's life-blood, as much as ever it was, is still the cotton industry, but there is a growing realisation, organise and reorganise as the industry will, that its former magnitude may never be regained, and new industrial outlets are therefore being sought. One of the first objects of the Development Council will be the compilation of an industrial survey of resources in the county area.

Steel Plant Out of Action.

Following very closely upon a rationalisation movement which resulted in a serious restriction of operations at the firm's works at Stalybridge, near Manchester, comes the announcement during the past few days that John Summers and Sons, Ltd., galvanised and black sheet manufacturers, of the Hawarden Bridge steel works Shotton, near Chester, are to close down their steel plant at Shotton, a decision which will affect about 2000 men. The causes are world-wide and are strikingly summarised in a statement by the chairman of the company, Mr. Henry Summers. Until about the beginning of last year, Messrs. Summers were able to maintain the greater part of their plant in operation, and about £26,000 was paid weekly to the 6000 men employed. The diminution in the ranks of the employees may easily be gauged from the

fact that less than £6000 a week is now being paid in wages. Formerly, about 90 per cent. of the company's production was exported, but world depression and industrial developments in overseas markets have combined to reduce that proportion to 25 per cent. It has been found impossible to compete with the much cheaper continental steel, and, in the words of Mr. Summers, the company has been reluctantly compelled to close down entirely the steel plant at Shotton and to purchase semi-finished materials from the Continent to maintain the sheet rolling mills in operation.

Non-ferrous Metals.

Another disastrous week has been experienced in all sections of the market for non-ferrous metals, prices showing further substantial declines, with no indication at the moment of writing of steadier conditions to come. In the case of copper, the demand from consuming interests here, as well as in the United States and on the Continent, have been extremely quiet, and there is little likelihood of any material revival of interest until users become convinced that the bottom of the renewed decline has been reached. With a measure of neglect also by speculators, copper is cheaper on balance by a further 15s. a ton, following upon a similar decline in the previous week. Loss of ground to the extent of between £3 and £4 a ton, compared with a week ago, has brought tin prices to about £16 below where they were in the middle of March, and buyers in this section are holding aloof. Sales of spelter have been very moderate indeed, and the week's fall of about 12s. 6d. a ton has made this metal cheaper than it has ever been before. Although transactions in lead have been fair in the aggregate, much of the tonnage involved is accounted for by speculative unloading, the trade demand having been quiet. Sooner or later, the output restriction schemes in operation or projected must have a steadying influence on non-ferrous metal prices, but in view of the prevailing weakness it is difficult to say how near or how far away that stage may be.

Iron and Steel.

Relative inactivity continues to be the keynote of business in the iron and steel markets here. Foundry iron users, except in very rare instances, are displaying no anxiety to enter into commitments extending beyond about a month, and with plentiful supplies of scrap material still obtainable at low rates the tonnage being disposed of by pig iron makers is unsatisfactory. For delivery to users in the Manchester district, Staffordshire, Derbyshire, and Cleveland irons are quoted at 69s. 6d. per ton, Northamptonshire at 68s., Scottish at about 88s. 6d., and West Coast hematite at 82s. 6d. Only a small business is being done in bar iron, values of which are at £10 5s. per ton for Lancashire Crown bars, and about £8 15s. for seconds. Small early delivery parcels are the general rule in the market for steel products, the majority of consumers in the heavy branches being too badly in need of work to consider seriously any resumption of contract buying. Joists are quoted at £8 15s. per ton, sections at £8 7s. 6d., general plates at £8 17s. 6d., large bars at £9 7s. 6d., locomotive boiler plates at about £9, and small re-rolled bars at £6 15s. A feature of the market for imported iron and steel materials is the weakness of semi-finished products, continental billets having been freely offered during the past week for delivery to users in the Manchester district at £4 per ton. One or two fair orders have been reported, but otherwise buying has been of a very spasmodic character.

BARROW-IN-FURNESS.

Hematite.

At the moment, the hematite pig iron market is quiet. There has been no improvement so far; in fact, the demand at present is a little easier, with the result that the present heavy stocks remain unreduced. The local requirements on the steel account eased off last week, but are now back at normal, but it is doubtful as to exactly how long they will be maintained. Consumers are disinclined to order a ton more than they absolutely need, and East Coast competition is being also felt. Continental business exists, but it is only quiet, and there has not been much American trade of late, although this might develop as soon as there is more activity in the United States. The local iron ore trade is dull and outside business is quiet. The demand for foreign ore is restricted in view of the small number of furnaces in blast in the district. The steel trade is quiet and the Barrow rail mills went off last Thursday, not restarting until this week. Workington has contracts for a month or two, and is better situated than Barrow. The bar and hoop mills are well circumstanced.

Shipbuilding and Engineering.

There is no confirmation as to the Portuguese order for destroyers and dispatch vessels. There appears, however, to be a certain amount of truth in the cable, which emanated from Lisbon, but it seems doubtful if any of the vessels will be built at Barrow. There will probably be some official announcement shortly, but this will be made in London and not at Barrow, where no information of any description is so far available.

SHEFFIELD.

(From our own Correspondent.)

Heavy Steel Production.

THE condition of things in the open-hearth steel trade goes from bad to worse. Production continues on a very reduced scale, and there is no sign of improvement. Hardly any forward buying is reported, and at the plants which make steel for sale the continuance of operations cannot be foreseen for more than a week or two ahead. The demand for basic scrap, which is a reliable index of the ups and downs of the heavy steel trade, is so poor that prices show a continued fall. They are now quite £1 less than they were a year ago. Since Easter they have receded a shilling or two. Large users are now offering about 41s. per ton, and, although holders will not sell a that price, they can no longer command the former price of 44s. No changes in the prices of iron and steel are announced. With conditions so depressed, it is felt that concessions would fail to stimulate business.

How the Furnaces are Employed.

Striking evidence of the extent to which production has recently declined are contained in the monthly report of the District Organiser of the Iron and Steel Trades Confederation to headquarters. The information with regard to the open-hearth melting plants in Sheffield and the immediate district is as follows:—Vickers works, two furnaces in commission, as compared with five given in the previous report; John Brown and Co., one furnace, as before; United Steel Companies, six, compared with nine; Samuel Fox and Co., two, compared with four; Parkgate Works, five compared with six; Industrial Steels, two, compared with four; Brown Bayley's Steel Works, two, compared with four; Hadfields, open-hearth and Bessemer plants at half capacity; John Baker and Bessemer, one furnace, as before; Andrews Toledo has started up a furnace. In Lincolnshire, the blast-furnaces and steel furnaces of the Frodingham Iron and Steel Company are idle, but the manufacturing plant is operating. Three of the blast-furnaces at the Appleby works are operating—an increase of one—and three of the open-hearth furnaces, as before; Lysaghts are continuing to work two blast-furnaces and five open-hearth furnaces; the Redbourne Hill Works are still standing idle. The unemployment figures are equally striking. Early in April there were 14,902 iron and steel workers wholly or temporarily unemployed in Sheffield; 1380 wholly and 2322 temporarily unemployed in Rotherham; and 1491 wholly and 530 temporarily unemployed in the Scunthorpe district.

Rolling and Manufacturing.

There has been a decline of work at the rolling mills during the last month. Wire mills are badly placed, and working up to hardly 50 per cent. capacity, and rod mills are in a similar situation. The mills at Appleby and Parkgate are at less than half capacity as regards the production of plates. The sheet mills are maintaining their previous position. While the position in some of the manufacturing departments is better than that in steel production, it is far from satisfactory, and further ground has been lost lately. Perhaps the best section is that of stainless steel and kindred materials, output of which continues to represent a substantial volume. There is a very fair demand for forgings, stampings, and other parts used in the construction of motor vehicles, as well as for special steel for the same purpose, but the requirements are not up to the scale of a year or two ago. There is a moderate home demand for best quality tool and special steels, and also for tools used in engineering and by mechanics, but the export trade has dwindled to very small proportions, and until overseas buying revives there can be no general improvement in the Sheffield industry.

A Heavy Loss.

The annual report of Sanderson Brothers and Newbould, Ltd., one of the oldest firms in Sheffield, which is engaged in the manufacture of files, edge tools, saws, machine knives, &c., is not pleasant reading. It shows a loss of £63,235, as compared with a profit of £10,571 for last year. The directors state that the trading loss is attributable to a large extent to the diminished output consequent upon a meagre demand for the products of the company and unprofitable prices. The exceedingly high expenses of the company have for some time past caused the directors considerable anxiety, and during the year the company's affairs have been thoroughly gone into, with the result that very substantial economies have been and are being made, the benefit of which ought to be felt during the current year. A heavy writing down of stocks-in-trade to the values at present prevailing has also been made, which has very considerably augmented the loss for the year.

Cutlery and Plate.

It is declared that the cutlery trade is going through the worst period of depression it has known in this generation. What makes the position all the more acute is that there are far too many suppliers for the existing demand, as a large number of new people have come into the business since the war. The means of production have also been considerably increased by the extended use of labour-saving machinery, and this further accentuates the difficulty brought about by scarcity of orders. As the falling off in railway traffic has hit one of the most important departments of the heavy steel trade, so has the slump in ocean passenger travelling, with its consequent enforced economy on the part of the shipping companies, had a serious effect on the cutlery and plate trades. The large steamship companies, which have been valuable customers of Sheffield for many years, are now buying much less table plate and cutlery than formerly. There is still a considerable demand from the public caterers, but it is not by any means up to the level of a year or two ago. So far as the ordinary call from shopkeepers is concerned, it consists principally of small orders. The demand for export is also very much split up, and there is a marked absence of substantial business. There is a fair demand for best pen and pocket knives, but very little for ivory-handled cutlery.

Railway Developments.

The L.N.E.R. Company is to give a trial to rails of 90ft. in length, or 30ft. longer than those now generally in use, with which it is to lay a mile of its main line immediately south of Thirsk. The experiment is an interesting one, and, it is hoped, will facilitate smoother running, owing to the lessened number of joints. A matter to be carefully watched in connection with it will be the thermal expansion and contraction of the metal. The rails are of the British standard weight of 95 lb. to the yard, and have been rolled at the mills of Pease and Partners, Carlin How. A scheme, costing about £100,000, is in progress on the L.M.S. Railway immediately south of Ambergate Station, Derbyshire, where the main London to Manchester line is being doubled. Three new viaducts are being provided, and are now in an advanced stage of construction. Another feature of the work is the opening out of the Longlands Tunnel, a five-course brick-faced tunnel, just over 100 yards in length. The L.N.E.R. main line from Alne to Pilmoor is to be widened, and a contract for the work has been placed with Fletcher and Co., of Mansfield.

Liner to be Broken Up.

It is announced that Thos. W. Ward, Ltd., of Sheffield, has purchased the Pacific Steam Navigation Company's liner "Orita," which will shortly be taken to the firm's yard at Morecambe, and, after being kept for a time for public inspection, will be broken up. She was for many years one of the most popular vessels sailing from Liverpool to South America, and during her career of nearly thirty years travelled about 3,000,000 miles. It is probable that she will be the last big ship to be dismantled at Messrs. Ward's yard in Morecambe Old Harbour, as the site has been claimed by the Corporation.

NORTH OF ENGLAND.

(From our own Correspondent.)

Big Work Possibilities.

THE chief interest in Northern industrial circles this week has been centred in the Weir Committee's report advocating the electrification of the British railways, for the scheme offers big possibilities of work in this area. Not only has Tyneside established itself as a centre of the electrical plant industry, but Armstrong-Whitworth's, a few months ago, became the prime contractors in the world market for the Armstrong-Sulzer Diesel-electric rail car, which will probably be favoured for use on branch lines. To Teesside and Cleveland the prospect of thousands of miles of steel rails and sleepers and hundreds of new locomotives being required in this revolution of transport, promises work in plenty for the iron and steel trade. It is estimated that once the scheme is embarked upon, employment will be found for 60,000 men, a big percentage of whom will, undoubtedly, be engaged in work in North-East Coast factories and workshops. The firm of Reyrolles, at Hebburn, is certain to benefit considerably from any scheme of general electrification. As a manufacturer of switchgear it is world-famous, and already has provided electrical plant for railways in this and other countries. The report of the Weir Committee favours actual electrification of the main lines instead of the substitution of self-generating units, such as the Armstrong-Sulzer car. The Committee's preference in this matter will be widely debated, and, of course, it has to be remembered that the report is merely a recommendation and not a decision on a course of action. In any case, the Weir Committee agrees that detailed examination may show that branch lines can be operated more economically by independent haulage units, either steam or oil-electric, like those being made at Scotswood. Armstrong-Sulzer plant has the advantage of obviating the need for expenditure on overhead lines and stationary power-houses. The car can be operated on existing trucks, and thereby offers a big saving in capital costs.

Cleveland Iron Trade.

Apprehensions regarding the Budget having been removed, the release of orders hitherto withheld is now expected. But the response has not been immediate and the demand for pig iron is still limited. One hopeful feature is the improvement in the shipments, but this is confined to hematite, Cleveland pig iron prices being too high to command attention abroad or even in Scotland. Consumers are disinclined to negotiate for forward supplies. The trend of values is downward, though producers complain that cost of output leaves but meagre profit. No. 1 Cleveland foundry iron is 61s., No. 3 G.M.B. 58s. 6d., No. 4 foundry 57s. 6d., and No. 4 forge 57s.

Hematite Pig Iron.

Sales of East Coast hematite pig iron are on a better scale. Consumers claim they can readily place orders on the basis of ordinary East Coast brands at 66s., and, indeed, business has been put through on lower terms, but there are producers who hold out for rather considerably more.

Ironmaking Materials.

The foreign ore trade is in a lifeless condition. There is no local outlet and quotations are weaker with best Rubio ore offered at 15s. 9d. c.i.f. Tees. Sellers of blast-furnace coke experience difficulty in arranging contracts, but are reluctant to grant price concessions and ask more for forward than for early supply. Good average qualities keep at 16s. for early delivery to works on the North-East Coast.

Manufactured Iron and Steel.

There has been a gratifying expansion in the steel export trade, and the April shipments from the Cleveland district will be the heaviest of any month this year. Home specifications are also coming in fairly steadily, but no very big orders are offering, and the bulk of the business is for near delivery. Shipbuilders are pressing for lower prices, but steel makers fail to see that any sacrifice in this direction would stimulate the demand, and quotations to home consumers are all kept unchanged.

The Coal Trade.

Inquiries for steam coals have become very meagre, and the undertone of the market has steadily eased. The home pressure for the past few weeks, however, was strong, absorbing a large proportion of the output, with a steadying effect on values. Now that these special conditions are no longer present, there is difficulty in securing trade sufficient to absorb the recent volume

of production. Overseas consumers hold off, and although the general opinion is that trade for May will be fairly well up to recent volume, fears are expressed that business in the summer months will be disappointing. Moreover, many anticipate that the minimum prices for the summer months will have to be lowered to allow the competition of foreign coal to be met. There is practically no new business passing to test steam coal values. Fitters are holding for 13s. 9d. for best Northumberland steams, against the nominal prices offering of 13s. 6d. Smalls are plentiful at 10s. There is a good trade in the best class Durham steam coal. Supplies are rather short of requirements, and 15s. 6d. large and 12s. small is firmly indicated. There is no special feature in the Durham gas coal market. Winter contracts are expiring, and with little new business to take their place the prospects ahead for gas coal are not encouraging. Buyers of any class can obtain them at easy prices. Best qualities are quoted at 14s. 6d. to 13s. 9d., and the special Durham qualities at 15s. Secondary gas remain a poor trade at 13s. 6d., while Durham coking unscreened give no sign of any revival of consumers' interest. Any good brand can be obtained at 13s. 3d. Durham unscreened bunkers are moving slowly, and are easy in price at 14s., with second qualities at 13s. 6d. Stocks of all classes of coke are steadily rising, and the position causes general uneasiness. German competition is increasing, and prices rule relatively much lower than home prices. Gas coke is not maintaining its recent steady tone, and with many seasonal contracts expiring and lack of new business, the trend is against makers at 20s. to 20s. 6d. Patent oven coke is in poor request, and weakly held at 15s. 6d. Beehive and superior foundry coke are also easy at 19s. to 24s.

Miners' Wages in Durham.

The miners' wages question in Durham County will remain in abeyance for another two months. A further meeting was held this week between the coal-owners and the men's representatives regarding the owners' application for a reduction in the percentage addition to basis wages and in the subsistence allowance. The men's side made counter-proposals, and it was agreed that further consideration of the question be deferred and that the present agreement be continued to the end of June.

SCOTLAND.

(*From our own Correspondent.*)

Unsatisfactory Conditions.

THROUGHOUT the steel, iron and coal trades conditions remain extremely unsatisfactory. No real improvement can be looked for while the situation is dominated as at present by the lack of demand from the consuming trades at home and abroad. There has been slightly more movement from certain quarters abroad, but this has been largely in the nature of a "feeler," and does not apparently indicate substantial progress towards the reopening of markets overseas.

Steel.

The dearth of new shipbuilding orders is telling severely against the demand for heavy steel. Plates and sections are poorly specified, and the works were never worse off for orders. Steel tubes are poorly specified, so much so that at least one factory has been idle now for some weeks. Signs in respect to sheets are perhaps a little more hopeful, owing to a little more movement in the Far East. Ordinary black sheets are moderately busy, but galvanised descriptions have ample room for improvement. A better demand for structural steel is reported. Prices as a rule are unchanged.

Iron.

Prospects in the iron trade were never more obscure. Usually at this season of the year some improvement has been noticeable, but this year so far there has been no indication of a seasonal buying, and ordinary purchasing is far below normal. Re-rolled steel bars at £6 16s. home and £6 7s. 6d per ton export experience very keen competition from continental and English makers, and business remains very restricted, and shows little variation from week to week.

Pig Iron.

Owing in a measure to importations of foundry and basic qualities, the turnover in pig iron is extremely small, and fairly heavy stocks are held, in spite of the fact that only seven furnaces are in operation. During the past week shipments of pig iron from Glasgow amounted to 157 tons (131 tons foreign), compared with 527 tons (409 tons foreign) in the same week last year.

Scrap.

Prices of scrap remain easy at 53s. 6d. for cast iron machinery and 45s. per ton for heavy steel.

Coal.

The Scottish coal trade shows little change. Home demands are shrinking with the advance of Summer Time, and the amount of fuel on offer cannot be absorbed with the export inquiry so restricted. Lanarkshire splints and Fife navigations alone maintain a firm position. All other descriptions of large fuel show a tendency to further weakness. Export business is still purely of a day-to-day character, shippers being unable to offer terms calculated to induce buyers abroad to contract ahead. Washed nuts are extremely plentiful, and prices are lower than at any time since the war. Aggregate shipments amounted to 208,831 tons, against 185,178 tons in the preceding week and 248,992 tons in the same week last year.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

Coal *versus* Oil and Electricity.

THE agitation that the Government should revert to the use of coal for the Navy in place of oil found its main expression at a conference of civic and commercial leaders at Cardiff on Friday last. The meeting was outstanding in the matter of representative character, as almost every organisation in South Wales concerned either with trade or the control of local affairs was represented. The Lord Mayor of Cardiff presided, and in connection with the movement a mass of information was forthcoming as to what the use of oil in place of coal meant to this district. It was pointed out that the miners alone lost in wages £2,219,000 a year, £793,000 per annum of that amount being represented by the decrease in the amount of coal supplied to the Admiralty. Then, again, there was the further loss of £600,000 a year in railway rates, tipping and weighing charges, most of which would have gone to railway and transport workers, while other losses which were sustained, but which cannot be estimated, were those suffered by seamen, drydock workers, and employees in the allied industries. The result of the meeting was that a representative committee was appointed with power to select a delegation to wait upon the Admiralty and place before the authorities the views held in this district, and the conference was then adjourned to such time as the committee consider it desirable to call the conference together again. Since then the proposals of the Weir Committee for the electrification of the British railways has caused some concern in South Wales, in view of the possibility of a considerable reduction in the consumption of coal. The Great Western Railway Company is, of course, a buyer of heavy quantities of Welsh coals for its system, between two and three million tons being mentioned as its consumption in a year, while it is estimated that the railways throughout the country use annually about 12,000,000 tons. In one quarter it is computed that the electrification of the railways would mean a diminution in coal requirements of 10,000,000 tons, but it is very difficult to say with any definiteness what would be the outcome, for if the position on the Continent is examined, it will be found that where substantial electrification schemes have been adopted, the demand for coal instead of decreasing has actually increased. However, the whole subject is very shortly to come before the South Wales Coalowners' Association for consideration.

The Coal Trade.

Shipments last week, according to the figures of the G.W.R. Company, totalled 491,700 tons, which compared with 513,000 tons for the preceding week, so that there was a falling off, and it is by no means certain that for the current week the returns will be at all good. The fact is that the tonnage situation is not favourable to the trade. At the end of last week the return of idle tipping appliances was as high as thirty-one, and arrivals of tonnage over the week-end only reduced this total to twenty-four, while on Tuesday the number was back to thirty-one again. The fact is that during the past week or two the favourable homeward business from the River Plate and Canada has been attracting tonnage. Quite a number of steamers have been despatched in this direction in ballast, including vessels which have been laid up. It is a favourable indication that this is the case, but at the same time it has meant that owners have not shown so much interest in freights for the Mediterranean, and charterers in need of prompt steamers for this direction have found it difficult to satisfy their requirements. The inevitable result is that rates of freight for the Mediterranean, especially for the upper ports, have displayed a definitely upward tendency. This, of course, does not suit those who have c.i.f. commitments, but at the same time it will in the long run be better for all concerned, when rates are established on a more remunerative and workable basis. For the moment, however, the fact that tonnage is not being put at the disposal of collieries as freely as was expected, is not helping them, and as there has not been much fresh business about the tone of the steam coal market is not quite so steady in some directions, though leading undertakings are fairly comfortable. Contract operations are also quiet, but the Norte Railways of Spain are reported to have placed their order for about 12,000 tons of steam coal, and it is now announced that the Egyptian State Railways, which last week contracted for 100,000 tons of Welsh locomotive coals, intend asking for fresh tenders in about three weeks' time for the balance of their requirements, viz., about 200,000 metric tons. In view of the fact that the rate of freight for Alexandria has moved up about 1s. per ton in the past week, the probability is that when new prices do go in they will be on a higher basis than the last tenders.

Mannesmann Tube Works.

The announcement was made at the end of last week by the general manager of the British Mannesmann Tube Company, Ltd., that in reviewing the position and as a result of the ballot they took of the men, the company had felt compelled for the future to renounce export business so far as its Landore works were concerned, because it was a business that could not be continued without a substantial loss. This meant that only 45 per cent. of the men who were formerly employed would be required. The firm was only now able to operate one shift per day for five days a week, and in doing this it had decided to fall into line with the hours worked by the Amalgamated Engineering Union workers—forty-seven hours per week. This position had, unfortunately, been forced upon the company by economic circumstances, and through the opposition and obstruction that had been met with. Sufficient applications for work had been received to operate the one shift per day, and the company now announced that those who had not replied to the company's letter were advised to seek work elsewhere. Engineers were being called into the works immediately to put the plant and machinery in thorough repair after the long stoppage in order to enable the works to open up in two or three weeks, as soon as sufficient orders for the home trade can be obtained.

Steelworkers' Wages.

It is shown by the ascertainment under the sliding scale agreement governing wages in the West Wales steel trade that the average selling price of bars for the three months ended March 31st was £4 17s. 4·021d. per ton f.o.t. makers' works. The basis price in the sliding scale agreement is £5 per ton, so that the effect of the present ascertainment upon the wages is that as from the first Sunday in May the sliding scale percentage will be at zero. This means a reduction to the men of 2½ per cent., compared with the previous ascertainment when the average price of bars was £5 5s. 6·753d., and will prevail until August 1st. The *ex-gratia* payments at present made to the lower-paid workmen will be given consideration at a later date.

Current Business.

The market for anthracite coals continues to be very steady, but the steam coal section has lost some of the recent improvement, and prices are all round back at the minimum under the schedule. Some of the leading collieries are comfortably placed for the time being, but others are suffering from a shortage of ready tonnage. Small coals are still easy, on account of the excessive supplies on the market, while coke and patent fuel show no alteration. Pitwood is a shade easier.

CATALOGUES.

SAMUEL FOX AND CO., Ltd., Stocksbridge Works, Sheffield.—A booklet dealing with all types of road vehicle springs, their design, materials and manufacture.

HOPKINSONS, Ltd., Huddersfield.—List No. 3110, "A Modern Shaft Signalling System," by W. B. Dale, M.I. Mech. E., dealing with the firm's patent mine signal indicators.

WM. BOBY AND CO., Ltd., 62–64, Brook-street, W. 1.—Particulars of the "Boby" safety continuous blow-down system, its objects and application to different types of boilers.

DAVID BROWN AND SONS (Huddersfield), Ltd., Lockwood, Huddersfield.—Data Sheet No. 1011, describing various types of speed-increasing gears for deep well and surface pumps.

ENGLISH ELECTRIC COMPANY, Ltd., Queen's House, Kingsway, W.C. 2.—"The English Electric Company and its Activities," a book printed in English, French, and Spanish.

HICK, HARGREAVES AND CO., Ltd., Bolton.—"Turbo-compressors, Blowers and Exhausters for Air or Gas," and "Rotary Compressors and Vacuum Pumps for Air and Gas."

HATTERSLEY (Ormskirk), Ltd., Ormskirk, Lancs.—A 190-page book giving particulars of the firm's fittings for locomotives, steam, heating, fire and water services in gun-metal, cast iron, and cast steel.

CONTRACTS.

SIR WILLIAM ARROL AND CO., Ltd., have received orders for one 30 cwt. overhead crane and gantry from Stewarts and Lloyds, Ltd., Coatbridge, and one 50-ton electric traverser from the Bombay, Baroda and Central India Railway Company.

GENERAL ELECTRIC COMPANY, Ltd., Magnet House, Kingsway, W.C. 2, has received an order from the London, Midland and Scottish Railway Company for two 1200-kW remote-controlled mercury arc rectifiers with starting gear for installation in the Upney-lane sub-station of the Barking-Upminster electrification scheme. These rectifiers will operate from an 11,000-volt, three-phase, 50 cycles supply and will feed into the traction system at 630 volts D.C.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

MR. FRANCIS THEAKSTON has severed his connection with Francis Theakston, Ltd., of 60, Tufton-street, S.W. 1, and Gresty Works, Crewe.

MESSRS. HENSCHEL AND SOHN, A.G., of Cassel, have taken over the locomotive business of the Hannoversche Maschinenbau A.G., formerly Georg Egestorff (Hanomag). Messrs. Gossell and Son, Ltd., 110, Cannon-street, E.C. 4, as representatives of Messrs. Henschel, will deal with inquiries connected with "Hanomag" locomotives, locomotive boilers, and spare parts.

AN amalgamation has been completed between Newtons of Taunton and T. Harding Churton and Co., Ltd., Atlas Works, Water-lane, Leeds. New centralised offices will be opened on May 4th at 3/5, Cavendish-place, Regent-street, London, W. 1. Telephone, Langham 4311 (six lines); telegrams, "Guidepost, Wesdo." The London office will deal with the business of both firms.

JUNIOR INSTITUTION OF ENGINEERS.—The dinner which was held to celebrate the forty-seventh anniversary of the foundation of the Junior Institution of Engineers was held at the Whitehall Rooms, Hotel Metropole, on Friday evening of last week. The chairman was Colonel Sir Henry G. Lyons, F.R.S., D.Sc., and over one hundred and seventeen members and guests attended, making the dinner one of the largest of recent years. In proposing the toast of "The Institution," Sir Cyril Kirkpatrick, Vice-president of the Institution of Civil Engineers, referred to the very friendly atmosphere of the "Juniors," and the good work the Institution was evidently doing at home and abroad by the introductions which it made possible. He appreciated the singular activity of the members, and suggested that the "Volcanic Society," an earlier name, would, perhaps, be a better title for the Institution. The toast was responded to by Mr. Edwin D. Gill, the present chairman of the Institution, who said that the members were out to help each other in every way, and recalled the fact that several of the founder members were still active. In the course of an informative talk, Sir Henry A. Miers, F.R.S., D.Sc., proposed the toast of "Science Museums," and commented on the great change which had taken place in recent years, transforming the "static" condition engendered by private collections in the older museums to the "dynamic" activities of our South Kensington Museum and the Deutsches Museum in Munich. In his reply, Sir Henry Lyons, who had just returned from Germany, paid a tribute to the very thorough way in which Dr.-Ing. Oskar von Miller had worked out the plan for the Deutsches Museum from the beginning. He expressed the hope that the new buildings which were so urgently needed for the effective housing of the South Kensington collection would soon be forthcoming. The toast of "Our Guests" was proposed by Mr. J. Forster Petree, A.M.I. Mech. E., a Vice-chairman of the Institution, and Dr. Standen L. Pearce, M.Inst. C.E., M.I.E.E., President-elect of the Institution, replied. Mr. A. J. Grant, Wh. Ex., M.I.N.A., also responded on behalf of the guests and said that he was so impressed by the good fellowship of the "Juniors" that he had decided to join them. The chairman was thanked by Mr. Horace P. Wright, a vice-chairman of the Institution.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
(1) Native	16/- to 20/6
(1) Spanish	16/-
N.E. Coast—	
Native	18/- to 21/-
Foreign (c.i.f.)	15/9

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	3 12 0	—
No. 1 Foundry	3 16 0	—
No. 3 Foundry	3 13 6	—
N.E. Coast—		
Hematite Mixed Nos.	3 6 0	3 6 0
No. 1	3 6 6	3 6 6
Cleveland—		
No. 1	3 1 0	3 1 0
Siliceous Iron	3 1 0	3 1 0
No. 3 G.M.B.	2 18 6	2 18 6
No. 4 Foundry	2 17 6	2 17 6
No. 4 Forge	2 17 0	2 17 0
Mottled	2 16 6	2 16 6
White	2 16 6	2 16 6
Midlands—		
(c) Staffs.—	(*Delivered to Station.*)	
All-mine (Cold Blast)	—	—
North Staffs. Forge	3 6 0	—
„ „ Foundry	3 11 0	—
(c) Northampton—		
Foundry No. 3	3 7 6	—
Forge	3 2 6	—
(c) Derbyshire—		
No. 3 Foundry	3 11 0	—
Forge	3 6 0	—
(3) Lincolnshire—		
No. 3 Foundry	—	—
No. 4 Forge	—	—
Basic	—	—
(4) N.W. Coast—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 1 6 (a) / 4 3 6 (b) / 4 8 6 (c)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	10 5 0	9 15 0
Best	—	—
N.E. Coast—		
Iron Rivets	11 10 0	—
Common Bars	10 10 0	—
Best Bars	11 0 0	—
Double Best Bars	11 10 0	—
Treble Best Bars	12 0 0	—
Lancs.—		
Crown Bars	10 5 0	—
Second Quality Bars	8 15 0	—
Hoops	13 0 0	—
S. Yorks.—		
Crown Bars	10 5 0	—
Best Bars	11 0 0	—
Hoops	12 0 0	—
Midlands—		
Crown Bars	9 10 0 to 10 7 6	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	8 12 6 to 9 0 0	—
Gas Tube Strip	10 17 6 to 11 0 0	—

STEEL. (*d*)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates (Marine)	10 10 0	10 10 0
„ „ (Land)	10 10 0	10 0 0
Ship Plates, ¼in. and up	8 15 0	7 15 0
Sections	8 7 6	7 7 6
Steel Sheets, ¼in.	8 5 0	8 0 0
Sheets (Gal. Cor. 24 B.G.)	11 7 6	11 0 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	8 15 0	7 15 0
Angles	8 7 6	7 7 6
Boiler Plates (Marine)	10 10 0	—
„ „ (Land)	10 0 0	—
Joists	8 15 0	7 7 6
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5s.
Hard Billets	8 2 6	—
Soft Billets	6 17 6	—
N.W. Coast—		
Barrow—		
Heavy Rails	8 5 0	—
Light Rails	8 10 0 to 8 15 0	—
Billets	6 10 0 to 9 0 0	—
Manchester—		
Bars (Round)	9 7 6	—
„ (Small Round)	6 15 0	—
Hoops (Baling)	10 0 0	9 15 0
„ (Soft Steel)	9 0 0	8 15 0
Plates	8 17 6 to 9 2 6	—
„ (Lancs. Boiler)	9 2 6	—
Sheffield—		
Siemens Acid Billets	9 10 0 (basis)	—
Hard Basic	8 12 6 and 9 2 6	—
Intermediate Basic	7 2 6 and 7 12 6	—
Soft Basic	6 5 0	—
Hoops	10 5 0	—
Soft Wire Rods	7 15 0	—
Midlands—		
Small Rolled Bars	7 0 0 to 8 0 0	—
Billets and Sheet Bars	5 5 0 to 5 15 0	—
Galv. Sheets, f.o.b. L'pool	11 0 0	—
(2) Staffordshire Hoops	9 10 0	—
(*d*) Angles	8 7 6	—
(*d*) Joists	8 15 0	—
(*d*) Tees	9 7 6	—
(*d*) Bridge and Tank Plates	8 17 6	—
Boiler Plates	9 0 0 to 9 2 6	—

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14 f.o.b.	15/- to 15/3
Block Tin (cash)	107 5 0
„ (three months)	108 12 6
Copper (cash)	41 16 3
„ (three months)	42 8 9
Spanish Lead (cash)	12 2 6
„ „ (three months)	12 3 9
Spelter (cash)	10 11 3
„ (three months)	11 0 0
Manchester—	
Copper, Best Selected Ingots	44 15 0
„ Electrolytic	45 10 0
„ Strong Sheets	75 0 0
„ Tubes (Basis Price), lb.	0 0 10½
Brass Tubes (Basis Price), lb.	0 0 9½
„ Condenser, lb.	0 0 11½
Lead, English	13 7 6
„ Foreign	12 12 6
Spelter	11 5 0
Aluminium (per ton—raw ingot)	£95

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/11½ per lb.	
Ferro Tungsten	1/8½ per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£21 0 0	7/-
„ „ 6 p.c. to 8 p.c.	£19 17 6	7/-
„ „ 8 p.c. to 10 p.c.	£19 12 6	7/-
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£31 0 0	10/-
„ „ „ 1 p.c. carbon	£34 0 0	12/-
„ „ „ 0·70 p.c. carbon	£36 0 0	14/-
„ „ „ carbon free	10d. per lb.	
Metallic Chromium	2/7 per lb.	
Ferro Manganese (per ton)	£11 0 0 for home	
„ „ „	£11 10 0 for export	
„ Silicon, 45 p.c. to 50 p.c.	£11 0 0 scale 5/- per unit	
„ „ 75 p.c.	£18 0 0 scale 7/- per unit	
„ Vanadium	12/9 per lb.	
„ Molybdenum	4/2 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£170	
Ferro Cobalt	9/- per lb.	

FUELS.

SCOTLAND.

	Export.
Lanarkshire—	
(f.o.b. Glasgow)—Steam	14/-
„ „ Ell	14/9
„ „ Splint	14/9 to 16/6
„ „ Trebles	12/-
„ „ Doubles	10/6
„ „ Singles	9/-
Ayrshire—	
(f.o.b. Ports)—Steam	13/-
„ „ Jewel	17/-
„ „ Trebles	12/-
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	11/6 to 12/3
Screened Navigation	16/6 to 17/6
Trebles	11/6 to 12/6
Doubles	10/6 to 11/-
Singles	9/-
Lothians—	
(f.o.b. Leith)—Best Steam	12/-
Secondary Steam	11/6
Trebles	12/- to 12/6
Doubles	11/-
Singles	9/-

ENGLAND.

(8) N.W. Coast—	
Steams	20/-
Household	30/- to 51/-
Coke	20/- to 20/6
Northumberland—	
Best Steams	13/6 to 14/-
Second Steams	12/- to 12/3
Steam Smalls	10/-
Unscreened	12/6 to 13/-
Household	27/- to 39/-
Durham—	
Best Gas	14/9 to 15/-
Second	13/3 to 13/6
Household	25/- to 37/-
Foundry Coke	26/- to 28/

Sheffield—	Inland.	
Best Hand-picked Branch	25/6 to 27/-	—
Derbyshire Best Bright House	24/- to 26/-	—
Best House Coal	22/- to 23/-	—
Screened House Coal	19/6 to 20/6	—
„ „ Nuts	16/6 to 17/6	—
Yorkshire Hards	15/- to 16/6	—
Derbyshire Hards	15/- to 16/6	—
Rough Slacks	9/- to 10/-	—
Nutty Slacks	7/- to 8/-	—
Smalls	4/6 to 6/6	—
Blast-furnace Coke (Inland)	12/3 on rail at ovens	
Furnace and Foundry Coke (Export), f.o.b. 15/- to 16/-		

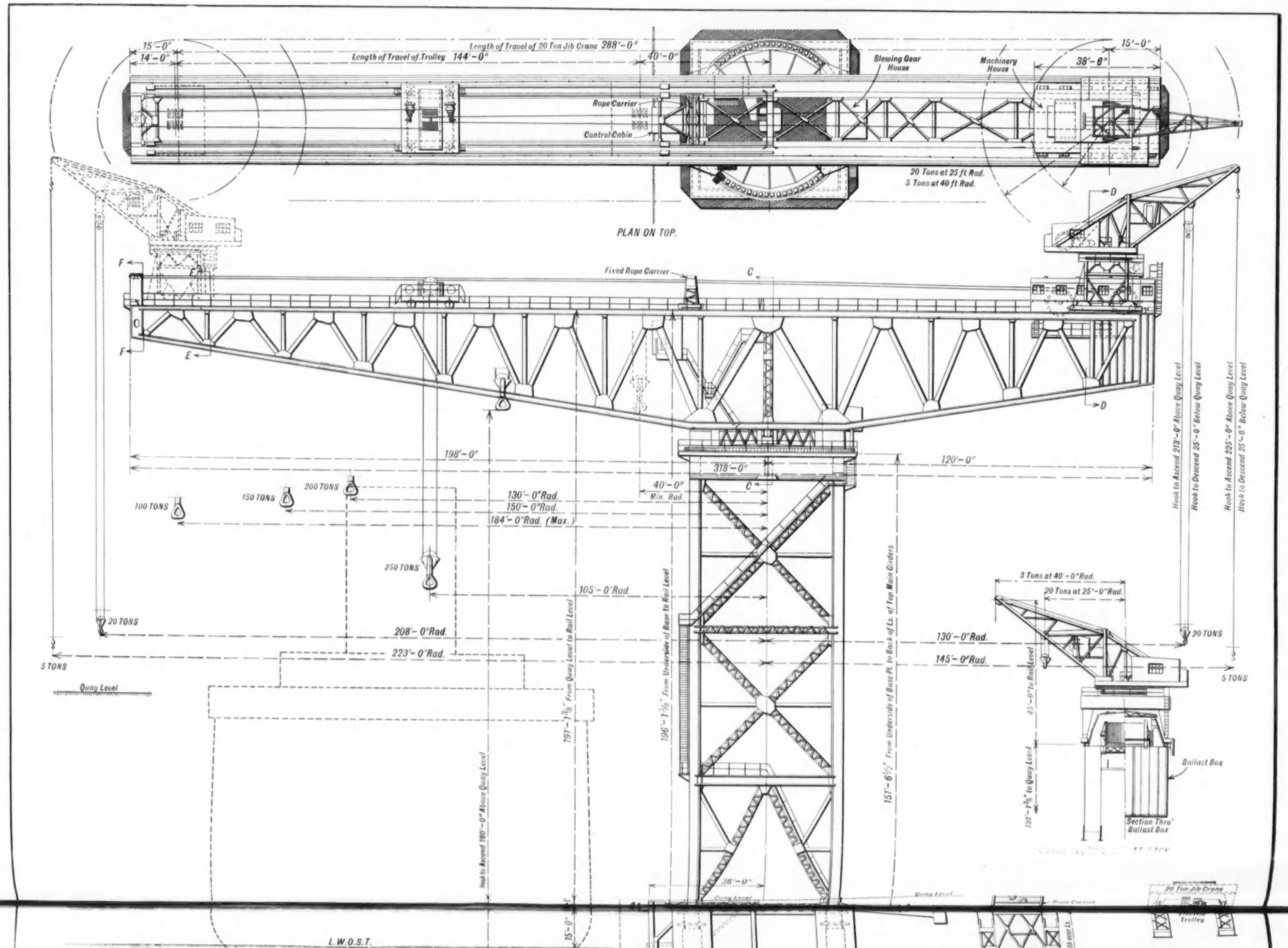
(9) SOUTH WALES.

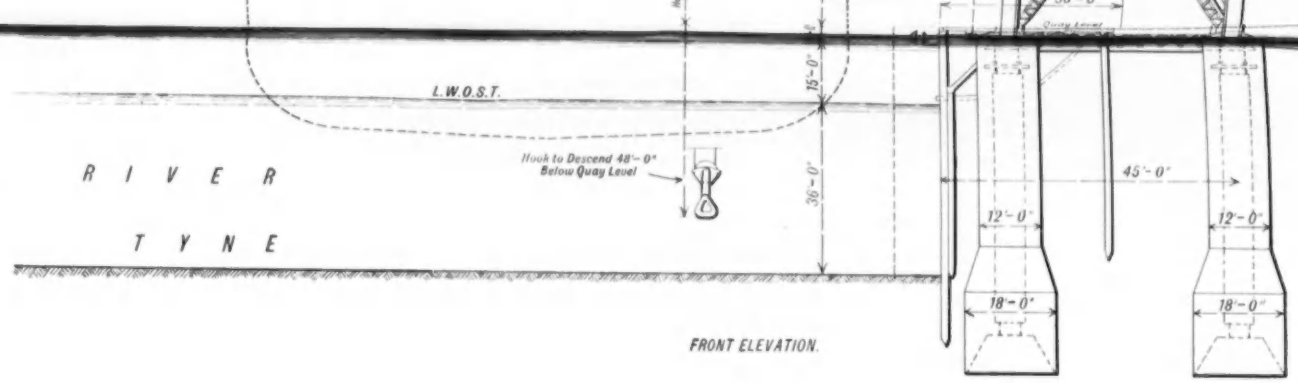
Cardiff—	
Steam Coals :	
Best Smokeless Large	20/- to 20/3
Second Smokeless Large	18/9 to 19/9
Best Dry Large	18/6 to 19/6
Ordinary Dry Large	17/9 to 18/-
Best Black Vein Large	18/6 to 18/9
Western Valley Large	18/- to 18/6
Best Eastern Valley Large	18/- to 18/3
Ordinary Eastern Valley Large	17/6 to 17/9
Best Steam Smalls	13/6 to 14/-
Ordinary Smalls	12/- to 13/6
Washed Nuts	18/- to 22/-
No. 3 Rhondda Large	19/9 to 20/3
„ „ Smalls	15/6 to 16/-
No. 2 „ Large	17/- to 17/3
„ „ Through	15/6 to 16/-
„ „ Smalls	14/- to 14/3
Foundry Coke (Export)	22/- to 36/6
Furnace Coke (Export)	16/6 to 17/6
Patent Fuel	20/6 to 21/-
Pitwood (ex ship)	23/9 to 24/-
Swansea—	
Anthracite Coals :	
Best Big Vein Large	35/- to 37/6
Seconds	27/- to 31/6
Red Vein	22/6 to 27/6
Machine-made Cobbles	41/6 to 45/-
Nuts	43/- to 46/-
Beans	24/9 to 28/3
Peas	20/- to 21/6
Breaker Duff	8/9 to 9/6
Rubbly Culm	8/6 to 9/6
Steam Coals :	
Large	20/6 to 21/6
Seconds	18/- to 20/-
Smalls	11/6 to 13/-
Cargo Through	16/- to 17/6

(1) Delivered. (2) Net Makers' Works. (3) f.o.b. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire, and Ayrshire. (6) Home Prices—All delivered Glasgow Station. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham. (*d*) Rebate : Joists (minimum), 22/6 ; Ordinary Ship, Bridge, and Tank Plates and Sections, 15/- if home consumers confine purchases from associated British Steel Makers. (*e*) Delivered Black Country Stations.

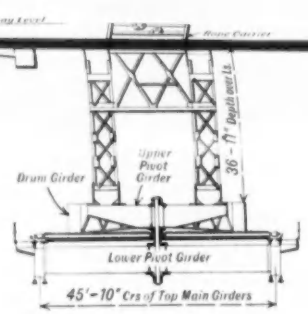
250-TON ELECTRIC HAMMERHEAD CRANE

SIR WILLIAM ARROL AND CO., LTD., GLASGOW, ENGINEERS

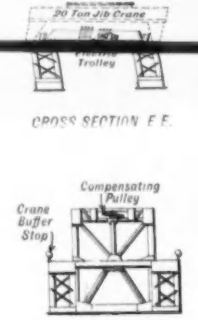




FRONT ELEVATION.

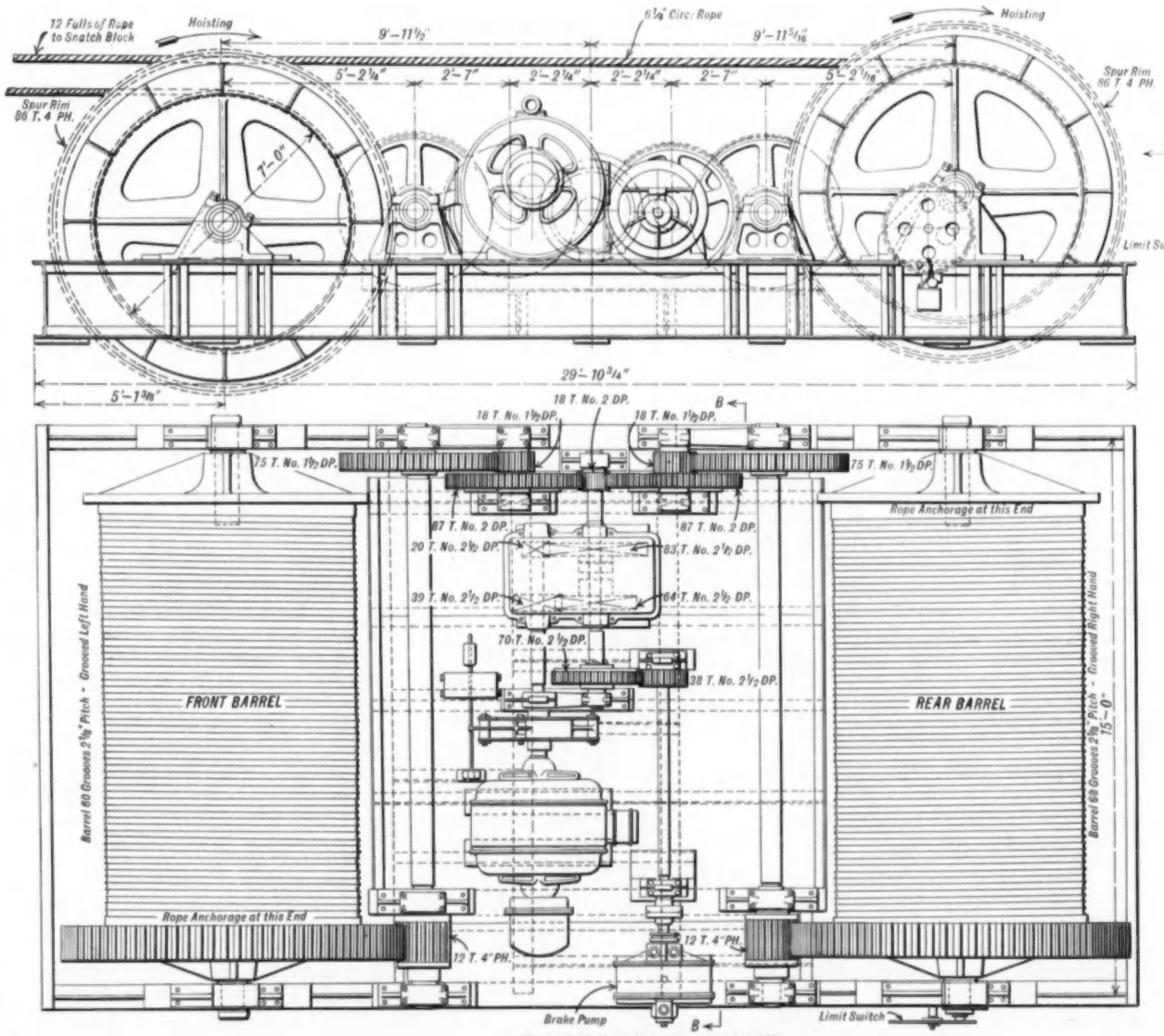


CROSS SECTION C.C. AT FRONT

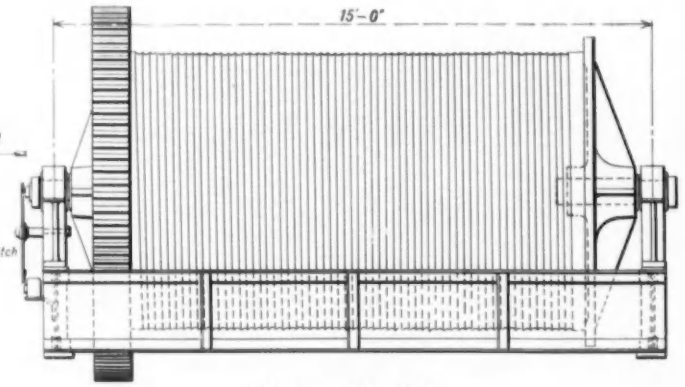


CROSS SECTION E.E.

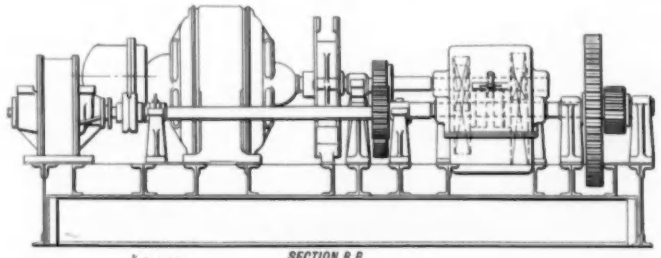
CROSS SECTION F.F.



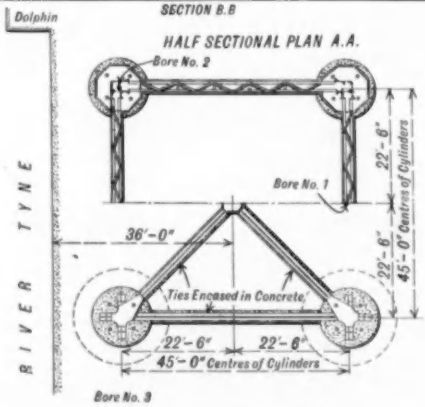
ARRANGEMENT OF HOISTING MACHINERY



VIEW IN DIRECTION OF ARROW A.



SECTION B.B



HALF SECTIONAL PLAN A.A.

HALF SECTIONAL PLAN B.B.

"THE ENGINEER"

UNIV. OF MICH.

French Engineering Notes.

(From our own Correspondent in Paris.)

European Trade.

THE fact that this country is less affected by the general trade collapse than other parts of Europe does not leave manufacturers with a false sense of security as to the future. Because the official unemployment figures are small, there is a tendency to represent the situation in a more favourable light than it really is, but everyone knows that trade is bad and is getting worse, and recent events have shown that some heroic measures must be undertaken internationally before there can be any hope of recovery. French confidence has so far been artificially sustained. It is now giving way to a fear of complications arising out of the conflict between the Briand plan and the German proposal, the one based on a protectionist system and political security and the other frankly on Free Trade. The conflict has done more than anything else to slacken the already restricted business activity, because it is feared that negotiations for economically reconstituting Europe will be long and arduous. France is less able than other countries to accept Free Trade. The tendency to fix quotas for imports under commercial agreements has grown of late, and an attempt may be made to extend it in a general way, in which case there would be an automatic adjustment of production to consumption. It is uneconomical in the sense that it tends to restrict competition, which is necessary to increased consumption, and it seems, therefore, that the French ideas will have to be modified considerably in view of the German offer of a more liberal system of international exchanges. How far France can go in the way of concession it is difficult to say. A country which has built up industries under cover of protection with the idea of becoming self-supporting, and now finds that those industries cannot be maintained with an export trade, will necessarily have to make sacrifices in order to carry out any practical scheme of European reconstruction. France hopes to escape this consequence by offering financial aid as a set-off against commercial advantages.

Anglo-French Tariffs.

The preliminary negotiations for a revision of the Treaty of Commerce of 1882 between Great Britain and France have disturbed the equanimity of manufacturers. The Association de l'Industrie et Agriculture has collected reports from the industries affected, and these reports indicate clearly the resistance that will be offered to the granting of further facilities for the importation of British goods. The Houillères de France point out that the import duties on coal are now less on a gold basis than they were before the war, and the competition of foreign coal can only be met by additional protection for home collieries. In the metallurgical, textile and other industries there are the same complaints of inadequate protection. It is remarked that the existing Tariff Bill was passed on the understanding that it represented a minimum that could in no case be lowered. The situation, it is argued, has now so far changed that an increase of tariffs is necessary if home industries are to be saved from disaster, this contention having reference, evidently, to the rise in the manufacturing costs in France, while those abroad are being reduced. Nevertheless, there is an impression that negotiations have been forced upon the French by suggestions that have been received in Great Britain from other countries. Manufacturers fear that it may be a case of France conceding advantages or of Great Britain making arrangements with Belgium, Holland and Scandinavia that will be detrimental to French commercial and other interests. That arrangement appears to be sufficiently in line with the German proposal to suggest the possibility that a more liberal system of commercial exchanges will be adopted in the North of Europe. Therefore, makers urge that if concessions must be made to Great Britain they should be arranged in a way to avoid their application elsewhere under the most favoured nation clause.

Rolling Stock.

The dwindling railway traffic receipts have a further depressing influence on an already sufficiently depressed industrial situation. In pursuance of the policy of strict economy which is being followed by the companies, few orders are being distributed, and efforts are being made even to cancel existing contracts. The five years' purchasing programme is, therefore, held up indefinitely, but the work already distributed under the programme will afford employment to wagon builders for some months to come, though no one can foresee what will happen beyond that period. The only hope for new business lies in the approval by the Polish Government of a concession to a French company which has been formed with a Polish group for the construction of a railway between Kotowice and the new port of Gdynia, near Dantzig. Apart from its strategical value, the line is intended to facilitate the export of coal from that port up to about 11 million tons a year. It is, of course, a necessary condition that some of the work will come to France, but as Polish locomotive builders have been competing successfully in the French Colonies, it is probable that French builders will have to make some sacrifice in order to secure their share of the work. In a similar way orders for rolling stock are expected from Rumania.

Canal Inundation.

The Canal de l'Ourcq is the last stage of the inland waterway system from the Nord to Paris, and is constructed with embankments through the flat area to the north-east of the city. One of the works being carried out for an extension of the port of Paris is the creation of new basins at Saint-Denis, and the Canal de l'Ourcq is being widened and deepened so that boats of bigger tonnage can navigate between the collieries in the Nord and Paris. During the course of these works, and for some reason as yet unexplained, a part of the embankment gave way and flooded a vast area between Aulnay and Saint-Denis. The breach has been repaired with sheet piling, and as accidents of this kind must be avoided in the future it is now proposed to reinforce the entire embankment with sheet piling at a cost of something like 3,000,000f.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

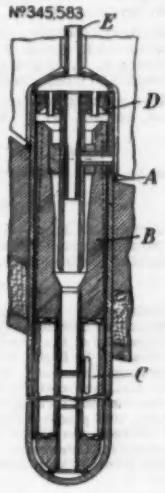
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date at the end of the abridgment, is the date of the acceptance of the complete Specification.

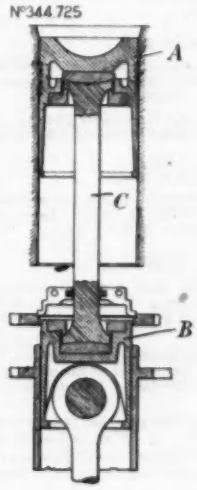
STEAM GENERATORS.

345,583. June 16th, 1930.—MERCURY BOILERS, *The British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C. 2.*

This apparatus is not really a *steam* generator, but may be classed therewith. Its object is to reduce the amount of the costly fluid—mercury—which is used for the production of vapour for power purposes. The boiler is of the familiar Field tube type, but efforts are made to confine the circulation within each tube within itself, so that each tube becomes, virtually, an independent boiler. The illustration shows one of the tubes welded into the boiler drum at A. Within the tube there is a core B, which has the result of providing a thin annular space for the passage of the mercury and thus reducing its total volume. The core has a central passage for the downward circulation of the mercury, which is insulated from outside heating effects by the air jacket C. The rising column of semi-evaporated mercury is caught and deflected by the curved diaphragm D, so that the liquid mercury is returned to the circuit, while the vapour escapes by the branch E to the main drum. It is not necessary to enlarge upon the details of the design, which are, nevertheless, indicated in the drawing.—*March 26th*, 1931.



INTERNAL COMBUSTION ENGINES.



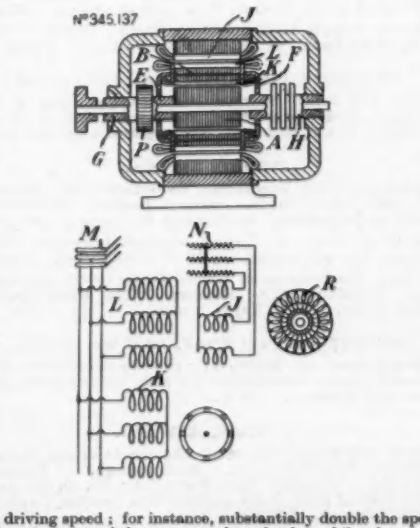
344,725. May 20th, 1930.—PISTON-RODS AND CROSS-HEADS, Sulzer Frères Société Anonyme, Winterthur, Switzerland.

This specification conveys a halting suggestion that the mechanism and alignment of an engine may not be all that is desired, and consequently may need accommodation. Between the piston A and the cross-head B there is a rod C, which has spherical faces at either end, so that it may accommodate itself to any alignment inequalities and yet transmit the working thrust. It is obvious that the arrangement is only applicable to single-acting engines.—*March 12th*, 1931.

DYNAMOS AND MOTORS.

345,137. April 24th, 1930.—DYNAMO-ELECTRIC MACHINES, *The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C. 2.*

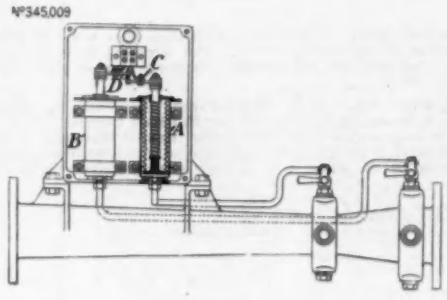
This invention relates to improvements in A.C. motors of the type having a double rotor, with the object of providing a very high driving speed; for instance, substantially double the speed of normal motors of the same number of poles, whilst the power factor may be made to reach unity, or the machine may draw a leading current. The main shaft carries a squirrel-cage rotor A. This rotor rotates within a second rotor B carried by the flanges E and F of the hollow shafts G and H, which are supported by bearings forming an integral part with the stator. The stator consists of a magnetic frame provided with the winding J arranged in slots, whilst the double magnetic frame of the rotor B has two windings K and L arranged in the same way respectively on its internal and external peripheries. As shown in the lower diagram, these windings are fed in parallel by means of slip rings M. If the current is switched on and the main shaft is prevented from turning by the load, the rotor B will begin to rotate and soon acquires a speed near synchronism. If, then, the winding J is connected with a starting rheostat N, owing to the field produced by L rotating in a direction opposite to that of the field produced by K, a speed is attained which corresponds to approximately the sum of the speeds of the two fields. The rotor B is also provided with a commutator P joined to an auxiliary winding R arranged like the winding L and with which it may be combined, and provided with sets of brushes which are connected with the winding J as soon as the machine has been started. It is thus possible to modify the speed and to bring the power factor to any desired value. It is also possible by means of the commutator to transform the machine into a synchronous motor, when the commutator then supplies continuous current to the winding J.—*March 19th*, 1931.



MEASURING AND TESTING INSTRUMENTS.

345,009. January 21st, 1930.—FLUID FLOW METERS, Serk Radiators, Ltd., Warwick-road, Greet, Birmingham; and C. H. Pattman.

This is not exactly a measuring device, but is intended to indicate if a flow of fluid entirely ceases, falls below a critical amount, or continues at the normal rate. It comprises a Venturi tube, the orifices of which are connected with two cylinders A and B. Inside these cylinders there are concertina diaphragms,

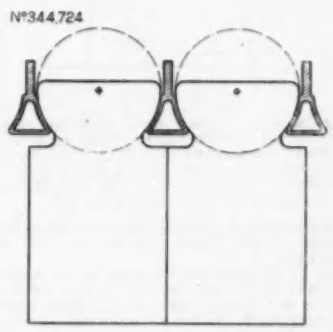


to which are attached the electric contacts C and D. When there is a flow through the Venturi these contacts are kept apart by the difference of pressure in the cylinders. If the flow ceases the pressures are equalised, the contacts close and an alarm is given. By arranging each contact under the control of a separate diaphragm variations caused by, for example, atmospheric pressure changes or equal pressure changes in the Venturi tube are automatically compensated.—*March 19th*, 1931.

FURNACES.

344,724. May 19th, 1930.—FURNACE ROOFS, E. Block, 93, Benderstrasse, Düsseldorf, Germany.

This specification suggests that damage to the suspended arch of a furnace may be caused by the local and unequal expansion

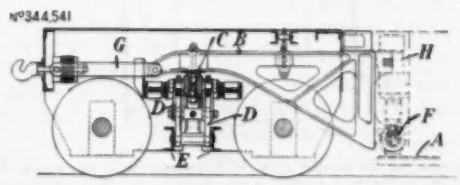


of the bricks, on account of local variations in temperature. As a consequence the inventor suspends the refractory bricks on cylindrical surfaces, as shown, rather than from angular dovetails, so that they may swing to accommodate expansion and contraction.—*March 12th*, 1931.

TRAMWAYS AND RAILWAYS.

344,541. December 13th, 1929.—BOGIES FOR BREAKDOWN CRANES, Craven Brothers (Manchester), Ltd., and A. E. Horrocks, Vauxhall Works, Reddish.

This invention is concerned with such heavy vehicles as railway breakdown cranes, which, during transit, must be partially supported on temporary bogies to relieve the weight on the main carrying wheels. A portion of the weight of the crane, represented in the drawing by the framing A, is transmitted to the



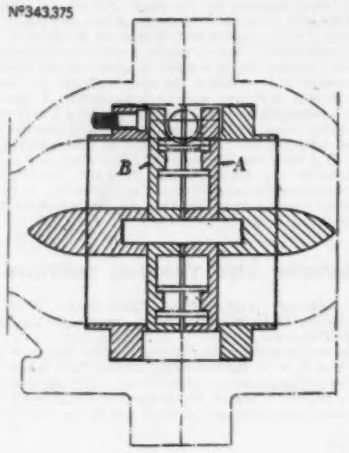
bogie by the hinged bracket B through the universal socket joint C and the toggle joints D D to the bogie framing E. By manipulating these toggles a portion of the load can be transferred to the bogie, or the hinged joint F, which connects the bracket with the main framing, may be relieved of load, so that the hinge pin can be pulled out and the bogie removed. The draw-bar stresses are transmitted directly to the bracket by the links G, and the buffing shocks through the bearing H.—*March 12th*, 1931.

MISCELLANEOUS.

343,375. April 8th, 1930.—Stop Valves, Cockburns, Ltd., and D. Macnicoll, Clydesdale Engineering Works, Cardonald, near Glasgow.

It is claimed that this valve reduces eddying and other

N°343,375

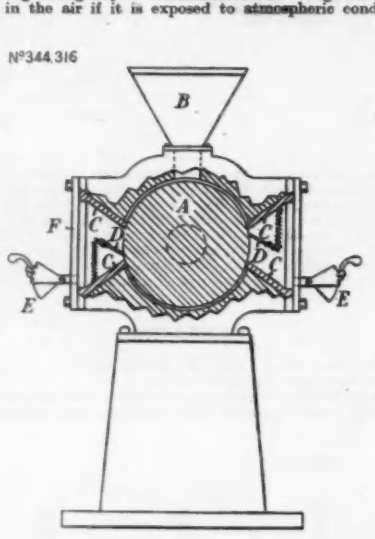


pressure losses. It acts through the two discs A and B being rotated in opposite directions. The discs are provided with sector-shaped ports which open or mask one another.—*February 19th*, 1931.

344,316. June 24th, 1930.—Paint Grinding Machines, S. Smith, 57, Quadrant House, Pall Mall, London, S.W. 1.

It would appear that the inventor is afraid that paint in the process of grinding may be contaminated with foreign substances carried in the air if it is exposed to atmospheric conditions.

N°344,316

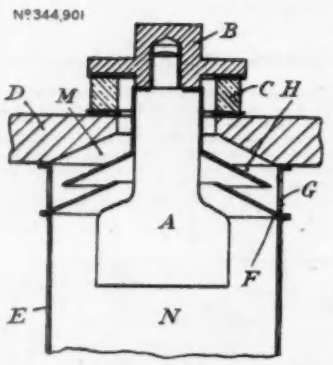


A grinding machine is consequently comprised of a grinding roll A, which is fed from the hopper B and the grinding blades C C C C. There are doctor knives D D, which scrape off the ground paint and deliver it through the outlets E E. The space in which the doctor knives work is, in each case, closed by a cover F to prevent the access of dirt.—*March 5th*, 1931.

344,901. November 5th, 1929.—Mercury Vapour Rectifiers, Aktiengesellschaft Brown, Boveri et Cie., of Baden, Switzerland.

According to this invention, the whole of the anode mounting of a metal-cased rectifier may be of very simple construction and complications which might cause trouble are avoided. In the drawing A is the anode, which is screwed into the closing flange B. For providing insulation between the closing flange B and the anode plate D the anode insulator C is provided. The anode sleeves E are fixed in place by means of an intermediate piece F which has the form of a lantern having an internal screen. On the anode stem screens H are mounted. In this way the space M

N°344,901



surrounding the anode stem communicates with the space N within the sleeve E in such a manner that mercury condensed in the space M and the mercury vapour atmosphere formed by it can escape laterally through the opening G and enter the space outside the sleeve, without passing through the space M within the sleeve E. In addition to this, owing to the considerable amount of heating in the space M, there is a greater absolute pressure at the anode A than outside the anode sleeve E. Hence there is a flow of vapour from the space N within the sleeve E to the space M, where, however, the mercury vapour does not stagnate, but escapes through the openings G into the space outside the anode sleeve E.—*March 5th*, 1931.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

Institution of Mechanical Engineers.—Storey's-gate, St. James's Park, London, S.W. 1. Informal meeting. "Selling Engineering Products," by Mr. John Harrison. 7 p.m.

National Institute of Industrial Psychology.—In the Hall of the Royal Society of Arts, John-street, Adelphi, London, W.C. 2. "The Causes of Juvenile Drifting," by Miss S. Bevington; "*Personnel* Work in Modern Industry," by Mr. A. H. Seymour. 6 p.m.

Physical Society.—Imperial College of Science, Imperial Institute-road, South Kensington, S.W. 7. "Cohesion," by Professor J. E. Lennard-Jones. 5 p.m. Editing Committee meeting, 3.30 p.m.; Council meeting, 4 p.m.

Royal Institution of Great Britain.—21, Albemarle-street, London, W. 1. Annual meeting. 5 p.m.

TO-DAY and SATURDAY, MAY 2nd.

Ideal Home Exhibition.—Olympia, W. Daily.

TO-DAY TO JUNE 30th.

Science Museum.—South Kensington, S.W. 7. Exhibition of transparancies illustrating the work of the National Physical Laboratory. Open daily.

SATURDAY, MAY 2nd.

Institution of Electrical Engineers: Meter and Instrument Section.—Visit to Cambridge, by invitation from the directors of the Cambridge Instrument Company, Ltd., and Professor C. E. Inglis, F.R.S., of the Engineering Laboratory of Cambridge University. 8.30 a.m., leave Liverpool-street Station; 10.30 a.m., arrive at the works, demonstrations will be arranged by the company; 12.45 p.m., lunch as the guests of the company; 2 p.m., visit places of interest in Cambridge, including some of the colleges, the Backs, and the river; 4.30 p.m., tea at the Engineering Laboratory, Cambridge, by invitation of Professor Inglis, inspect the Laboratory; 7.10 p.m., leave Cambridge by train.

Institution of Municipal and County Engineers.—Eastern District Meeting at Chelmsford. Assemble, County Hotel. 11.30 a.m.

Institution of Municipal and County Engineers.—North-Eastern District meeting at Newcastle-upon-Tyne. Council Chamber, Town Hall. 10.45 a.m.

MONDAY, MAY 4th.

Society of Chemical Industry.—In the Chemical Society's Rooms, Burlington House, Piccadilly, W. 1. "The Constitution of Coal," by Professor W. A. Bone, F.R.S. 5 p.m.

Society of Engineers.—At the Geological Society, Burlington House, Piccadilly, W. 1. "Hoof Dams," by Mr. A. M. A. Struben. 6 p.m.

TUESDAY, MAY 5th.

Institution of Civil Engineers.—Great George-street, Westminster, S.W. 1. James Forrest Lecture, "Engineering Research," by Sir Thomas E. Stanton, F.R.S. 6 p.m.

WEDNESDAY, MAY 6th.

Institute of Metals.—In the Hall of the Institution of Mechanical Engineers, Storey's-gate, Westminster, S.W. 1. Annual May Lecture, "Progress of Power Production," by Mr. W. B. Woodhouse. 8 p.m.

Institution of Civil Engineers: Manchester and District Association.—Visit to the cement works of G. and T. Earle (1925), Ltd., at Hope, Derbyshire. Leave Manchester 1 p.m.

Institution of Electrical Engineers.—Savoy-place, Victoria Embankment, London, W.C. 2. Wireless Section meeting. Discussion, "Technical Problems in Connection with Television." 6 p.m.

WEDNESDAY and THURSDAY, MAY 6th and 7th.

Institution of Municipal and County Engineers.—Irish Free State District Meeting at 35, Dawson-street, Dublin. 10.30 a.m. daily.

THURSDAY, MAY 7th.

Institution of Structural Engineers.—10, Upper Belgrave-street, S.W. 1. Discussion, "The Practical Design of Steel Compression Members." 6.30 p.m.

Iron and Steel Institute.—Grand Hall, Connaught Rooms, Great Queen-street, London, W.C. Annual dinner. 7.30 p.m.

Royal Dublin Society.—Ball's Bridge, Dublin. "Electricity on the Farm," by Mr. R. Borlase Matthews. 2 p.m.

THURSDAY and FRIDAY, MAY 7th and 8th.

Iron and Steel Institute.—At the Institution of Civil Engineers, Great George-street, Westminster, S.W. 1. Annual meetings. 10 a.m. each day. For programme see page 440.

FRIDAY, MAY 8th.

Institution of Electrical Engineers.—The Foresters' Hall, Nicol-street, Dundee. Faraday Lecture, "The Birth of Electrical Engineering," by Professor W. Cramp. 7.30 p.m.

Railway Club.—57, Fetter-lane, London, E.C. 4. "Great Southern Railway, Ireland," by Mr C. R. G. Stuart. 7.30 p.m.

Royal Institution of Great Britain.—21 Albemarle-street, Piccadilly, W. 1. Discourse, "The Measurement of Noise," by Dr. G. W. C. Kaye. 9 p.m.

FRIDAY and SATURDAY, MAY 8th and 9th.

Institution of Municipal and County Engineers: North-Western District.—Town Hall, Victoria-street, Morecambe and Heysham. 11 a.m.

MONDAY, MAY 11th.

Iron and Steel Institute.—At the Cleveland Technical Institute, Corporation-road, Middlesbrough. "Production Economy in Iron and Steel Works," by Mr. O. Cromberg; "The Melting Shop of the Appleby Iron Company, Ltd.," by Mr. A. Robinson. 7.30 p.m.

TUESDAY, MAY 12th.

Institution of Civil Engineers.—Great George-street, Westminster, S.W. 1. Annual General Meeting. 6 p.m.

WEDNESDAY, MAY 13th.

Royal Society of Arts.—John-street, Adelphi, London, W.C. 2. "Architecture in Concrete on the Pacific Coast," by Major R. A. B. Smith. 8 p.m.

THURSDAY, MAY 14th.

Iron and Steel Institute.—At the Birmingham Chamber of Commerce, 95, New-street, Birmingham. "First Report on the Corrosion of Iron and Steel," being a report by a Joint Committee of the Iron and Steel Institute and the National Federation of Iron and Steel Manufacturers to the Iron and Steel Industrial Research Council; "Production Economy in Iron and Steel Works," by Mr. O. Cromberg; "On the Nature of Defective Laminations in Wrought Iron Bars and Chain Links," by Mr. H. J. Gough and Mr. A. J. Murphy; "The Melting Shop of the Appleby Iron Company, Ltd.," by Mr. A. Robinson. 7 p.m.

FRIDAY, MAY 15th.

Royal Institution of Great Britain.—21, Albemarle-street, London, W. 1. Discourse, "Experimental Aspects of Hydrogen-Ion Concentration," by Dr. J. C. Philip, F.R.S. 9 p.m.

SATURDAY, MAY 16th.

Institution of Municipal and County Engineers.—Southern District Meeting at Cheltenham. Assemble Town Hall at 10.30 a.m.

FRIDAY, MAY 22nd.

Royal Institution of Great Britain.—21, Albemarle-street, London, W. 1. Discourse, "X-ray Investigations of the Structure of Liquids," by Sir William Bragg, F.R.S. 9 p.m.

SATURDAY to SUNDAY, MAY 30th to JUNE 14th.

Institute of Transport.—Italian Tour and Congress. For provisional programme see page 359.

MONDAY to FRIDAY, JUNE 1st to 5th.

International Federation for Housing and Town Planning.—Berlin. Thirteenth International Housing and Town Planning Congress.

THURSDAY, JUNE 4th.

Royal Society of Arts.—John-street, Adelphi, London, W.C. 2. "A New Form of Prime Mover and its Uses for Locomotives, Marine and other Engines," by Mr. J. F. J. Malone. 6 p.m.

WEDNESDAY, JUNE 24th.

Staffordshire Iron and Steel Institute.—Annual excursion. Visit to the National Physical Laboratory, Teddington.

MONDAY to SATURDAY, JULY 13th to 18th.

Society of Chemical Industry.—Jubilee Celebrations. For provisional programme see page 471.

Naming Timbers.—A very handy method of enabling the proper name to be given to practically any piece of commercial timber has been devised by Lister and Co., the timber merchants of Greenwich. It takes the form of a series of small slabs of wood prepared so that the grain is well exposed on all six sides, and each piece is plainly marked with its common name, not the botanical one. There are forty-three specimens, and they are packed in a solid teak box. The price of the set is half a guinea, and it should be very useful to those who are not very familiar with the appearance of the different kinds of hard and soft woods.

The Manchester Steam Users' Association.—The Manchester Steam Users' Association was founded by Sir William Fairbairn in 1854, and is the oldest organisation of its kind in this country. It is run purely for the benefit of its members, and is not merely an insurance company, for although it does issue financial cover upon boilers and engines—which is the equivalent of an insurance—that is by no means the full extent of its activities, which, in a word, may be described as the protection and fostering of the interests of boiler users in the broadest sense. It has just issued a little brochure in which its activities are described.

University College.—The University of London has just issued an attractive brochure describing the courses of study in the Faculty of Engineering of University College, London, leading to the degree of B.Sc. (Engineering) of the University of London and the Diploma of the College. Amongst the illustrations is included a reproduction of Alphonse Legros' portrait sketch of Sir Alexander Kennedy. During the last few years a sum of about £80,000 has been spent on new buildings, laboratory equipment and endowment, and every effort has been made to ensure thoroughly modern training in the scientific principles on which engineering practice is based.

Creeper Chains.—In some types of tub creeper chains for collieries the horn is a separate casting or forging, which is bolted to one of the links. This design, however, is, according to Hadfields, Ltd., being generally superseded by one in which the horn or claw is cast integrally with the link. This is being done for two reasons—first, it is cheaper to make, since there is no fitting required; secondly, being in one solid piece it is better able to withstand the impact of the tub axles than the built-up one, the horn of which is liable in course of time to work loose. In the Hadfield design the links and horns are made of "Era" manganese steel, and the rollers of best toughened cast steel.

A Presentation on Retirement.—An informal dinner was held at the Grand Hotel, Manchester, on Friday, the 17th inst., to mark the retirement—after 22 years—of Mr. H. B. Whitmore from his position as chief draughtsman of the Lancashire Dynamo and Motor Company, Ltd., and to wish him every success in his new work as a consulting engineer. As a token of appreciation and esteem and in recognition of his valuable friendship and ever-ready help, Mr. Whitmore was presented by Mr. B. Stevenson, on behalf of the L.D. and M. staff, with a carved oak bureau, surmounted by a bookcase, together with a revolving chair to match. Mr. Whitmore was also presented with a case of pipes by Mr. L. H. A. Carr on behalf of several past colleagues.

Rugby Engineering Society.—In the course of a paper on "Steel Ship Design," which was read before the Rugby Engineering Society recently, Mr. John Anderson, M.I.N.A., of Scotts Shipbuilding and Engineering Company, Ltd., dealt in a brief and interesting way with the various points in the design and construction of a modern steel ship and her propelling machinery. With regard to choice of propelling machinery, the author said that his own experience indicated that:—(1) The ordinary reciprocating steam engine was the most suitable for all ordinary cargo and all coasting vessels of normal draught. (2) In vessels of between 2500 and 10,000 horse-power and having a full speed steaming time efficiency of 52 per cent., the Diesel engine was most efficient and was followed by the turbine. (3) The latest developments in turbine installations made them most suitable and desirable for the high powers usually associated with passenger liners. (4) Coal was generally found to be more economical than oil under boilers, but, on account of its reduced weight, and the ease and speed of putting it on board, oil was sometimes necessary and desirable for fast passenger vessels employed on long voyages.